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ANALYSIS OF COMMERCIAL EQUIPMENT AND INSTRUMENTATION FOR SPACELAB PAYLOADS

(CONTRACT NAS8-30541)

VOLUME II. TECHNICAL REPORT

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FOREWORD

The Analysis of Commercial Equipment and Instrumentation for Spacelab Payloads was performed by the Space Division of Rockwell International Corporation under Contract NAS8-30541 for the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration. The study explores the feasibility of using commercially available laboratory equipment and instrumentation in the Spacelab, a Shuttle payload, in support of various sortie-mode experiments. The work was managed by Richard P. Arras (Telephone (213) 594-3807) of the Applications Programs area of the Space Division of Rockwell International. The study was administered under the technical direction of Mr. Charles W. Quantock (Telephone (205) 453-3425) of the Payload Studies group of Program Development of the Marshall Space Flight Center.

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1.0 INTRODUCTION

To date, the major portion of the cost of space hardware has been incurred by the design, development, and qualification of custom-built equipment. This equipment is typically produced to meet stringent specifications associated with the high reliability required and the environment encountered on infrequent space missions using expendable launch vehicles. The Shuttle experiment program will be different in the following ways: (1) flights will be more frequent, (2) the Spacelab environment will be earth-like, and (3) on-board equipment will be returned to earth after each flight. These differences, together with the presence of man, increase the potential for use of commercial equipment in the Spacelab.

The use of available commercial, airborne or military (CAM) equipment could result in significant reduction in sortie payload costs, thus allowing many more payloads to be flown. This will be a particular benefit early in the Shuttle program. In addition to the cost savings provided by using CAM equipment, it is anticipated other benefits will result such as shortening equipment procurement lead time and providing flexibility for the principal investigator to employ some of the same equipment in space as used in his ground-based laboratory. These benefits have the potential of significantly improving the value of the space program.

The importance of these benefits has been recognized in the planning for Spacelab which includes the design objective that standard laboratory equipment be accommodated without extensive modification. This study is particularly timely since a better understanding of the role of CAM equipment is needed soon to effectively implement the above objectives and to plan long lead-time payload developments.

This study examines a representative group of experiment equipment and develops quantitative cost tradeoff data to extend earlier feasibility assessments. Data and recommendations have been generated to assist in developing NASA specifications that do not unnecessarily restrict the use of CAM equipment in the Spacelab. The study further recommends equipment for NASA procurement for testing and identifies the preferred source of equipment modifications.

1.1 STUDY OBJECTIVES

The objective of this study is to investigate analytically the feasibility of using commercially available laboratory equipment and instrumentation in the Spacelab in support of various experiments. "Commercially available" has been interpreted to mean any equipment identified in a catalog including commercial, airborne and military (CAM) equipments. Feasibility is to be demonstrated by the breadth of application of CAM equipment to experiment equipment requirements in the Spacelab, and the cost effectiveness of utilizing this class of equipment instead of custom-built aerospace equipment typical of past designs.

Six specific objectives were satisfied in the analysis of the feasibility of CAM equipment:

1. Compilation of a list of representative equipment and instrumentation meeting the requirements of Spacelab experiments. This list is indicative of the available hardware that could be flown aboard the Spacelab.

2. Selection of a limited number of these items for analysis. These items were representative of the full equipment list to assure coverage of as many design variations as possible.

3. Collection of engineering specifications and data relative to these items. A library of manuals and specifications has been accumulated for the selected equipment.

4. Analysis of these data with respect to applicability for use in the Spacelab. The suitability of the selected equipment to space operations was assessed from specifications and visual examination. Modifications were identified where necessary and the cost of the modified hardware was compared to similar custom-built hardware.

5. Tradeoff analyses of specification requirements with respect to cost. Alternative requirements, compatible with the use of commercial hardware, were evaluated and specification changes were recommended which will reduce Spacelab equipment costs.

6. Recommendations for procurement of specific items for more extensive future test and analyses.

1.2 OVERALL APPROACH

This section presents a task-by-task discussion of the technical approach to the study. The study approach is discussed with reference to the study flow diagram of Figure 1-1.

Task 1. Identification and Selection of Potential Commercial Equipment and Instrumentation for Analysis

The Shuttle System Payload Data Activity (SSPDA) and other studies have identified types of instruments and equipment required to accomplish Spacelab experiments. Candidate commercially available equipment and instrumentation were identified, the degree of modification required to meet experiment functional requirements was assessed for each of them, and items were selected for detailed analyses throughout the study.

A listing of Spacelab instruments and equipment items and their functional requirements was developed, based on SSPDA data and other studies. Commonality of instrument usage across various disciplines was assessed. The instrument and equipment items identified were then categorized by their commercial

availability and extent of modification required to meet experiment functional requirements. Vendor catalogs were searched to identify available equipment meeting these requirements. In parallel with these activities a selection logic was developed to identify items representing a cross-section of Spacelab experiment equipment for further analysis in the study. A limited number of equipment items were selected, based on this selection logic, for analysis in Task 2.

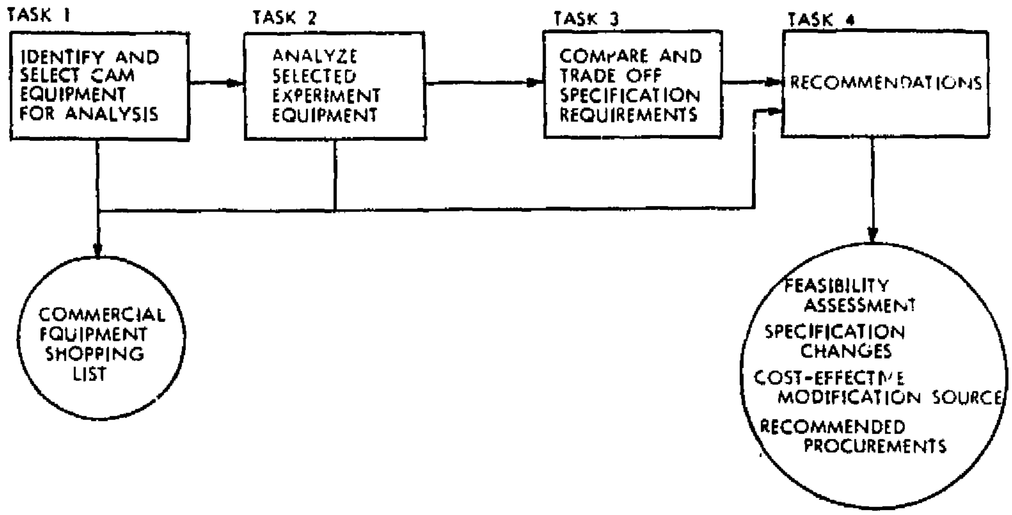

Figure 1-1. Overall Study Flow

Task 2. Analysis of Selected Items of Equipment and Instrumentation

The most cost-effective approach for Spacelab equipment and instrumentation development was determined from a cost analysis which compared commercially available equipment modified to be suitable for space flight with equipment custom built for the Spacelab.

The suitability of commercially available equipment for installation and operation in the Spacelab was determined first. Physical and performance data were collected for each of the pieces of selected equipment. This activity spanned a number of weeks and occurred in parallel with all other Task 2 subtasks because of the time required to obtain comprehensive information. Available information from the Spacelab and Shuttle programs provided the basis for the development of a Spacelab/Equipment Interface Requirements document which served as the specification for all equipment to be placed in the Spacelab. Equipment characteristics were compared with this interface requirements document to identify discrepancies which make the existing equipment unsuitable for space flight.

The cost of equipment modifications to eliminate the previously identified discrepancies were compared with custom-built equipment which meet space flight requirements. Modifications required by the suitability analysis were developed

conceptually. Descriptions of these modifications provided information to manufacturing planning and estimating personnel for determination of the shop cost for the modification. Supplemental costs to be added to the shop costs were identified for a complete determination of the cost of modification. In a parallel activity, the cost of custom building the equipment was determined. The two costs were compared and the cost-effective approach identified.

Task 3. Compare the Specifications of the (Modified) Experiment Equipment and Instrumentation with NASA Specification

The objectives of this task were to (1) evaluate the impact of imposing NASA Specification EC006M00000A requirements on the selected commercial equipment requirements, and (2) define and evaluate feasible alternative approaches to the accommodation of commercial equipment in the Spacelab. Task 2 established a set of Spacelab requirements and the needed item-by-item modifications and costs for compliance. Task 3 established the added cost for further modification of design, test, and processing for EC006M00000A compliance and then determined how the feasibility of using commercial hardware in space could be improved by changing this specification.

The initial activity consisted of a comparison of the EC006 and the study specifications. Delta costs that would accrue if the NASA specification were enforced were derived. Modified user equipment capabilities/requirements were compared to EC006M00000A for the purpose of identifying additional discrepancies to those identified in Task 2. Having identified the differences between modified equipment characteristics and EC006 specification requirements, the hardware and process changes to the modified items necessary to meet EC006 were identified, costed, and evaluated using the same procedures as in Task 2.

The characteristics of unmodified equipment were assembled and compared with corresponding requirements in the EC specification to identify requirements that must be cost effectively relaxed. Alternative Spacelab equipment specification requirements and the resultant system impacts were established. The advantages and disadvantages (from cost, performance, reliability, and safety points of view) of adopting each alternative requirement were assessed.

Task 4. Develop Recommendations

Task 4 integrated the outputs from all the previous study tasks to: (1) assess the overall feasibility of using commercial equipment in the Spacelab; (2) make specification change recommendations; and (3) develop a list of equipment for NASA procurement. In addition, a major trade was performed to determine the preferred source of the necessary equipment modifications.

Candidate specification changes were evaluated with respect to the entire Spacelab experiment program and change recommendations were made which would make the use of commercial equipment more cost effective. The modification source trade was performed defining the most cost-effective agency to perform the prescribed modifications. These outputs, as well as Tasks 2 and 3 results, were integrated to produce an overall feasibility assessment of the applicability of commercial hardware to the Spacelab program. The principal study findings were then used to select a list of hardware items for NASA procurement.

1.3 SUMMARY

The final report of this study consists of three volumes:

Volume I Executive Summary
Volume II Technical Report
Volume III Design Analyses and Trade Studies

Volume II presents the discussion of technical results of the study. It consists of two parts. The first part contains the technical discussion. and the second contains five appendixes to the discussion. This discussion is organized similar to the study task breakdown. A brief summary of the results discussed in each section follows.

1.3.1 Selection of Equipment for Analysis

Section 2 of this volume describes the approach employed to select specific available hardware items for analysis. The major outputs of this effort were a Spacelab experiment functional requirements data bank, a shopping list of available hardware that meets these functional requirements, and a list of equipment items selected for further analysis. The functional requirements data bank consists of a tabulation of equipment requirements for over 600 equipment items. These items were identified in SSPDA and other specific sortie payload studies. Functional modification classifications are also documented on this tabulation. The shopping list consists of a separate tabulation of approximately 500 equipment items which satisfy the requirements established in the functional requirements data bank. This tabulation and the data bank tabulation have been included in the appendixes. Thirty-four packages, consisting of 43 separate items, were selected from the shopping list for further analysis. The selection criteria emphasized higher cost equipment items, assuming that they offered the greatest potential for savings through the use of available hardware. The resultant group was also representative of the various types of equipment expected for Spacelab experiment operations.

1.3.2 Analysis of Selected Equipment

The suitability of the selected equipment items for installation in the Spacelab and the cost effectiveness of modifying available CAM equipment are presented in Section 3.0 of this volume. The major outputs of this effort were the Spacelab/Experiment Equipment Interface Requirements (SEEIR) specification, definition of the modifications required to make the selected equipment suitable for installation and operation in the Spacelab, and a comparison of the cost of this modified equipment to the cost of the same hardware custom built.

The SEEIR represents the first equipment specification derived with the use of commercial equipment in space in mind. It does not contain many of the typical requirements included in previous manned spacecraft specifications. The specification appears in Appendix D of this volume.

Unsuitable characteristics of the 34 selected equipment items were defined from visual inspection and a comparison of documented specifications for each item. The internal construction of 29 of 34 of the selected items was visually examined by the study team to assess structural integrity for acceleration and vibration loading, adequacy of cooling provisions, and the acceptability of materials used. Modifications ranged from stiffening printed circuit boards and replacement of unsecured screws to survive vibration, to a total redesign of gravity-dependent functions. Three units--a Coulter blood cell counter, a refrigerator/freezer and a dewar--required such extensive modification that they could only be custom built.

The comparison of modified and custom-built hardware costs indicates significant savings can be achieved by modifying available hardware. The average cost to custom-build the 34 selected items was estimated to be $225,000. The average cost of similar available hardware including all modifications is $31,000, an average savings of approximately 85 percent of the custom-built hardware cost. Detailed descriptions of the suitability analysis, modification details, and cost estimates are presented for each equipment item in Section 2.0 of Volume III.

1.3.3 Analysis of Specifications

Section 4.0 presents the results of the comparison of the study-developed interface specification (SEEIR) and a typical NASA equipment specification consistent with the previous manned spacecraft practice. Major output of the effort is the determination of the cost impact of imposing a rigorous manned spacecraft-type specification on the selected equipment items and identification of approaches to relaxing specifications to make them more suitable to the use of available CAM equipment.

The impact of the NASA specification (EC006M00000A) upon the selected hardware is two-fold. First, additional modifications to the selected hardware are required to meet more rigorous criteria such as worst case temperature limits. Secondly, additional systems engineering time is required to document additional analytical and test results required by the EC specification. Delta costs incurred by these additional activities averaged $30,000 per unit. Descriptions of the delta modifications and costs are presented for each equipment item in Section 2.0 of Volume III.

Four tradeoffs are also presented in Section 4.0. These tradeoffs examine relaxation of the equipment specification. Approaches to relaxing the equipment vibration environment, reducing material control restraints, and eliminating fungus and corrosion requirements are examined. A fourth tradeoff was performed to determine whether elimination of the power supply sections of most equipment is feasible and cost effective. The results of the tradeoffs indicate possible cost savings with little increase in risk if specifications are relaxed for corrosion and fungus. Material control can be relaxed to be consistent with that defined in the Spacelab/Experiment Equipment Interface Requirements document without reducing the safety integrity of the Spacelab. Reduction of the vibration environment to a level eliminating all equipment modifications defined for vibration integrity could not be cost effectively accomplished. Finally,

elimination of the power supply sections to be compatible with dc power resulted in the addition of dc-to-dc converter sections to each unit which show no performance improvement over the original configuration but do cause increased modification costs.

1.3.4 Modification Source Tradeoff

The cost-effective modification agency was determined by a tradeoff analysis of three alternative modification sources. Section 5.0 compares the advantages and disadvantages of the original equipment manufacturer, a centralized industrial contractor, or NASA performing equipment modifications. The analysis of the three alternatives consisted of an assessment of the differences between hardware process flows through each facility, polling of a number of manufacturers to determine their capability and willingness to perform the types of modifications identified by this study, and a review of the production facilities of two instrumentation manufacturers--Beckman Instruments and Hewlett-Packard.

The results of the assessment show that the original equipment manufacturer is the most cost-effective modifier of its own equipment. This conclusion was based on the immediate availability of equipment for modification, the potential for modifying equipment during the existing assembly process, and the familiarity of the manufacturer with his own equipment.

1.3.5 Recommended Equipment Procurements

Section 6.0 presents a list of eight pieces of equipment recommended for procurement by NASA-MSFC for test evaluation. The CVT program will be evaluating CAM hardware characteristics with an extensive testing program. This study has recommended the purchase of eight units in addition to those currently in the CVT inventory. The objective of the selection process was to satisfy two goals. First, equipment was identified that could provide the largest dollar savings to the Spacelab experiment program if available hardware were used. The second goal was to recommend an equipment group that would maximize the data return for the minimum expenditure of funds.

1.3.6 Conclusions

Use of CAM equipment in the Spacelab will be cost effective. Extension of the savings estimated for the 34 selected equipment items to the entire Spacelab experiment program indicates potential savings ranging from $230 million to $1230 million, depending upon the equipment development and replacement scenario adopted. The most probable savings amount is believed to be approximately $400 million.

2.0 SELECTION OF EQUIPMENT FOR ANALYSIS

2.1 INTRODUCTION

The objective of the first study task was to select a small group of available hardware representative of the types of hardware that could be used for Spacelab experimentation. This section describes the activities performed in the selection of this hardware.

Figure 2-1 illustrates the logic leading up to hardware selection. Results of the Shuttle System Payload Data Activity (SSPDA) and specific detailed payload studies provided package functional performance requirements data. These functional requirements have been assembled on a single computer tabulation. Common equipment requirements were identified across disciplines by collating the inputs by equipment type. Instruments and equipment types were categorized according to their availability and extent of modification required to meet experiment functional requirements. Catalogs from various suppliers were consulted to identify available equipment that meet the defined functional requirements. These equipments are tabulated on IBM cards forming a shopping list from which equipment items for further analysis were selected. A selection criterion stressing total procurement cost and representation of the design characteristics of available equipment was employed to select items from the shopping list.

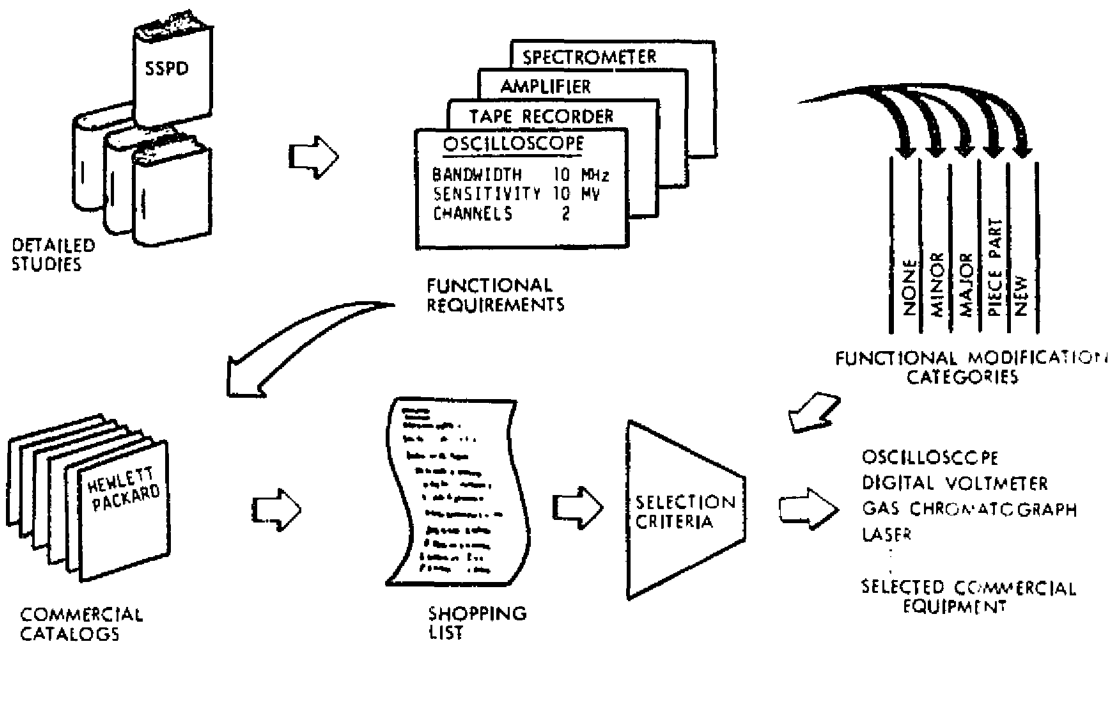

Figure 2-1. Commercial Equipment Identification and Selection Logic

Thirty-four available packages were selected. In a few cases, the selected packages consisted of more than one hardware element, leading to a total of 43 specific pieces of hardware for analysis. The suitability to space operations and the modifications required to assure operation on board the Spacelab are discussed in Section 3.0.

2.2 FUNCTIONAL REQUIREMENTS DATA BANK

Functional requirements have been defined for 615 equipment items, located in the Spacelab, identified in the following science and application disciplines: Astronomy, Solar Physics, Atmospheric and Space Physics, Earth Observations, Earth and Ocean Physics, Space Processing Applications, Life Sciences, Space Technology, and Communication and Navigation. Four hundred forty-four different types of equipment were identified from the 615 data bank entries. These data have been recorded on IBM cards to allow sorting by equipment type and to facilitate any updating or revision of this information. The resultant tabulation is presented in Appendix A of this volume.

Many Shuttle sortie mode payload studies have documented the experiment equipment performance requirements necessary to achieve experiment objectives. The Shuttle System Payload Data Activity (SSPDA) has identified many of these equipment items. Information from SSPDA, supplemented by the data from individual payload studies, was gathered, forming a functional requirements data bank for use in this study.

The source information used to generate the data bank is shown in Table 2-1. Specific payload studies generally provided additional data to the SSPDA tabulation. In many cases, the SSPDA data did not report information at the package level, resulting in the use of information from these payload studies as the primary source of data. For example, in the Space Processing and Life Science disciplines, experiment modules containing families of equipment are identified on the SSPDA tabulation. In these cases, equipment items and their functional requirements were obtained entirely from the payload study. The Manned Earth Observatory (MEO) study posed an additional problem in that this sortie payload is no longer identified on the Shuttle mission model. SSPDA tabulations reference this study in both the Earth Observations and the Earth and Ocean Physics disciplines; however, the experiment objectives are not the same. Since the intent of this study is to examine hardware representative of all types of sortie payloads it was decided to include information from this study on the tabulation. The MEO information is included under the Earth Observations discipline.

Hardware identified in the functional requirements data bank are the only kinds of interest to the study. Spacelab subsystem hardware has been excluded. All hardware is located in the Spacelab. Applicability of commercial hardware to pallet installation exposed directly to the space environment appears limited. Therefore, pallet-mounted hardware was excluded. Consumables such as film, tape reels, etc., and low-cost components identified in some studies are also not included to keep the tabulation manageable.

Table 2-1. Functional Requirements Data Bank Source Documents

1. NAS8-29462, Shuttle System Payload Data Activity (GDCA/Rockwell/GE)
2. Payload Element Data Sheets and Final Report of the Space Shuttle Payload Planning Working Groups (NASA-GSFC)
3. NAS8-28938, Requirements and Concepts for Materials Science and Manufacturing in Space Payload Equipment Study (TRW)
4. NAS8-29150, Life Science Payload Definition and Integration Study
5. Advanced Technology Laboratory Phase A Study Final Report (NASA-Langley)
6. NAS1-11674, Manned Activity Scheduling Study Final Report (GDCA)
7. NAS8-27540, Definition of Experiments and Instruments for a Communication/Navigation Research Laboratory (TRW)
8. NAS8-28144, Astronomy Sortie Mission Study (MMC)
9. NAS8-28047, Plasma Physics and Environmental Perturbation Laboratory (TRW)
10. NAS9-12255, Preliminary Design Study for an Atmospheric Science Facility (MMC)
11. NAS9-12649, Scientific Design of a Shuttle Auroral Observatory System (U. of Alaska)
12. NAS8-28013, Mission Requirements for a Manned Earth Observatory (TRW)
13. NAS8-27861, Zero-Gravity Cloud Physics Laboratory (MDAC)

Functional requirements for each item were obtained from the referenced literature when available. If the data were not available, experts were consulted by the study team and their best judgment was used to define appropriate functional requirements. Commercial hardware could not have been identified for many pieces of experiment equipment if this had not been done. As experiments become better defined, functional requirements can be updated and applicable equipment can be identified.

2.2.1 Explanation of Tabulation

A sample from the functional requirements data bank tabulation is shown in Figure 2-2. The listing is organized as follows. Each piece of equipment is described by a title card, a narrative description of the function of that piece of equipment, and a listing of its key functional requirements. The title card contains additional information as shown by the headings on the figure. Numbers in the left-hand column identify the equipment-type category. This categorization is consistent with that defined by Science Magazine in its "Guide to Scientific Instrumentation, 1972-73." The title of the piece of equipment is followed by its SSPDA equipment identification number (i.e., SP001). The next group of numbers identifies the quantity of that item on the payload, its location (I, inside Spacelab; E, external to Spacelab), the state of the art of this hardware (1, current; 2, advanced), the source of the hardware (1, commercial; 2, aircraft; 3, manned space; and 4, unmanned space), and finally the functional modification required by the available hardware (1, none; 2, minor; 3, major; 4, assembled from piece parts; and 5, new development). The final columns sequentially order the data by scientific discipline, SSPDA payload, and equipment item.

EQUIP TYPE	EQUIPMENT TITLE	SSPDA EQUIP IDENTIFICATION	QUANTITY / LOCATION / STATE OF ART / SOURCE / FUNCTIONAL MODIFICATIONS	DISPLAY SEQ.	
186000	HOT WALL TUBE FURNACE	SP002	31111	60230101	TITLE CARD
186000				60230102	NARRATIVE
186000	THIS UNIT IS A GENERAL PURPOSE,HOT WALL HEATING DEVICE			60230103	
186000	PROVIDING ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH			60230104	
186000	RESPECT TO A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.			60230105	
186000				60230106	FUNCTIONAL REQUIREMENTS
186000	VACUUM LEVEL...................2E-8 PSI (195E-4N/M2)			60230107	
186000	OPERATING TEMPERATURE.........2200F (1200C)			60230108	
186000	MAX EXTERNAL SURFACE TEMP.....110F (45C)			60230109	
186000	HOT ZONE DIMENSIONS...........2.5 IN (6CM) DIA. X 6IN(15CM)LNG			60230110	
186000	MAXIMUM DEVIATION FROM FLAT			60230111	
186000	PROFILE...................+/-4F (+/-2C)			60230112	
186000				60230113	
186000	HOT WALL FURNACE	SP002	21111	60230201	TITLE CARD
186000				60230202	NARRATIVE
186000	THIS UNIT IS A GENERAL PURPOSE, HOT WALL HEATING DEVICE PROVIDING			60230203	
186000	ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH RESPECT TO			60230204	
186000	A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.			60230205	
186000				60230206	FUNCTIONAL REQUIREMENTS
186000	VACUUM LEVEL...................2E-8 PSI (1.5E-4N/M2)			60230207	
186000	OPERATING TEMPERATURE.........3300F (1800C)			60230208	
186000	EXTERNAL SURFACE TEMPERATURE..110F (45C)			60230209	
186000	HOT ZONE DIMENSIONS(MIN)......1IN. (2.5CM)DIA.X5IN.(13CM)LONG			60230210	
186000	MAXIMUM DEVIATION FROM FLAT			60230211	
186000	PROFILE..................+/-7F (+/-4C)			60230212	
186000	VIEWPORTS.....................2			60230213	
186000				60230214	

Figure 2-2. Functional Requirements Sorted According to Science and Application Disciplines

Identification of each equipment item included its respective SSPDA identification number where possible. Exceptions to this practice were required whenever additional data were found in the supporting studies. Only external equipment is identified in the SSPDA tabulation in the Astronomy, High-Energy Astrophysics and Solar Physics disciplines. The Astronomy Module study by Martin was used as a model for the internal equipment of these three disciplines. This study indicated the basic support hardware required by the display and control console in the Spacelab. Study of these disciplines indicates that most of the experiment hardware is pallet mounted, and very little additional hardware except a control console would be located in the Spacelab. Listing of the Zero-G Cloud Physics Laboratory hardware is consistent with SSPDA, but the MEO is not (for reasons explained earlier). This hardware is clearly indicated by an MEO rather than an SSPDA part number in the listing. Space processing numbers relate to the SSPDA modular assembly that includes the subject package. In cases where a package is used in more than one module, only the first module was indicated. However, the total quantity was adjusted to include the items identified in the other modules. Changeout of hardware from one module to another was assumed not to be cost effective. Finally, Life Science and Communication/Navigation part numbers that were taken from the sortie payload reports were given 900 (or higher) series numbers.

2.2.2 Functional Modifications

Commercially available hardware may require modification to achieve an experiment performance objective, or it may require modification to be capable of operation on board the Spacelab. The study primarily addresses this latter type of incompatibility (Section 3.0). However, a gross assessment of the capability of available hardware to meet the functional requirements of Shuttle-sortie mode experiments was accomplished during this study task. This assessment was based on a similar assessment performed during the SSPDA study, available data from commercial equipment catalogs, sortie payload studies, and the study team's best judgment. The results of the functional modification assessment appear in the functional requirements data bank.

The functional modification categories are explained in Table 2-2. Figure 2-3 summarizes the results of the functional modification assessment. It is significant that the functional requirements of 282 out of the 444 different items identified could be satisfied by available hardware. Of the 282 items, 247 (55 percent of the total) did not require any modification to meet these requirements. These results show good correlation with experience in the ASSESS program.[1] The applicability of available equipment results from two factors. First, much of the equipment inside the Spacelab is experiment support hardware. Hardware such as oscilloscopes, frequency generators and gas chromatographs exist with diverse capabilities. Specialized hardware unique to space exploration is more frequently located on the Spacelab pallet than in the pressurized module. Secondly, many of the experiments are similar to those performed on the ground, differing only in that they are performed in a space environment. Since commercial laboratory instrumentation is typically used in the ground experiments, it is not surprising that the equipment would meet defined functional requirements.

[1]NASA TMX 62,287. Study of Airborne Science Experiment Management Concepts for Application to Shuttle, Volume 2. Donald R. Mulholland, et al. Airborne Science Office, NASA-Ames Research Center, Moffett Field, California; July 1973.

Table 2-2. Functional Modification Category Definitions

Category	Definition
None	Package can accomplish all functional requirements in the laboratory.
Minor	All functional requirements can be met except one or two. Only minor modification need be done to meet these requirements. No advancement in the state of the art is required.
Major	Primary functional requirements can be met but many secondary requirements cannot, or more than two functional requirements require modification but basic unit is still applicable. No advance in state of the art is required.
Assembled from available piece parts	Required package does not exist in a catalog. No advancement in the state of the art is required. Package can be made from existing piece parts.
New development	Commercial package not available; requires advancement in state of the art.

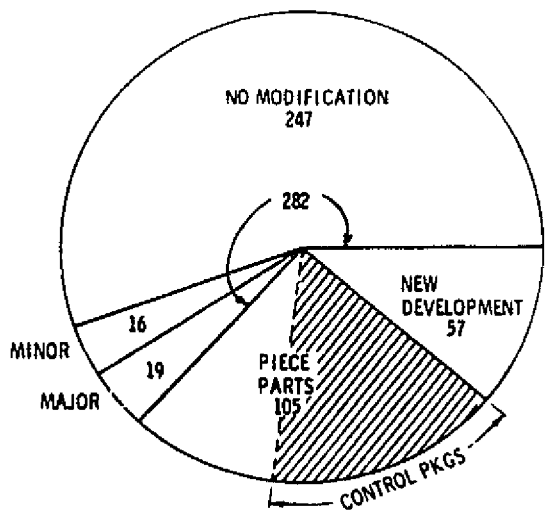

Figure 2-3. Function Modification Summary

The remaining segments on the figure show the number of items that must be custom built. Units which must be custom built, but are not new developments, are included in the piece-part segment. Equipment items that fell into this category were assemblies and control electronics. This segment may be distorted by 63 control packages identified for the Ames payload. This quantity might be reduced if a central processor and data bus concept were employed. The percentage of available equipment meeting functional requirements without modification would then increase to 65 percent. Items categorized as new developments include items which have been identified as SRT items in the sortie payload studies such as the particle counters identified in the Zero-G Cloud Physics Laboratory or are typically custom-built units such as cloud chambers in the same payload, or combustion chambers employed in the Advanced Technology Laboratory.

2.3 SHOPPING LIST

Available CAM equipment which satisfies the functional requirements tabulated in the data bank has been identified by reviewing manufacturer catalogs. Over 425 different items have been identified. A tabulation of these items has been included in Appendix B. Manufacturer, part number, current cost, and key performance capabilities are listed for each item. The listing is representative of the equipment available today and is by no means exhaustive. It includes a large enough quantity of equipment to assure selection of representative hardware for further analysis in the study.

2.3.1 Explanation of Tabulation

A sample of the shopping list tabulation is shown in Figure 2-4. The equipment type is first identified. Then, the requirements in the functional data bank are tabulated. (These requirements are not shown on the figure.) Next, the applicable commercial items are identified by part number and cost for each equipment type. For example, the Astro Model A222 (costing $1000), the Lindberg Model F8417 (costing $355) and the Leco Model 521-300 (costing $1370) hot wall tube furnaces satisfy the requirements for this type of furnace defined in the Space Processing sortie experiment payloads. The Astro Model 1100V (costing $3100) satisfies the requirements for the hot wall furnace in this discipline. The three numbers following the price indicate the specification to which the hardware is built (1, commercial; 2, aircraft, 3, military; 4, unmanned space; and 5, manned space), the technology status (1, current; 2, advanced), and the modification category (same as explained in the functional requirements data bank). For example, the Lindberg and Leco furnaces require major modification (Category 3) to achieve a vacuum in the oven. Significant performance capabilities for each identified piece of hardware are listed below the identifier cards. Numbers in the right-hand columns are for sequencing.

2.4 SELECTION OF CANDIDATE EQUIPMENT FOR FURTHER ANALYSIS

A criterion for selection of hardware for further analysis, from the hundreds of items in the shopping list, was developed. This criterion was used to select the items for in-depth analysis to determine their suitability for space operations and to identify the modifications necessary to make them suitable.

HOT WALL TUBE FURNACE	PART NUMBER		COST	SPECIFICATION / STATE OF THE ART / FUNCTIONAL MODIFICATION
ASTRO INDUSTRIES INC	#A222		$1000	122
HOT ZONE DIMENSIONS		5 CM DIA. BY 28 CM LONG		
MAX SUSTAINED TEMP		1200 DEG C		
LINDBERG HEVI-DUTY	#F8417		$355	113
MAX OPERATING TEMPERATURE		2200F (1200C)		
CHAMBER SIZE		1IN I.D.X 12IN LONG		
POWER		970W		
LECO	#521-300		$1370	113
INDUCTION FURNACE				
TEMPERATURE(MAX)................		>3000F (>1700C)		
POWER...........................		1.5KW		

HOT WALL FURNACE

SP-02 302 2

ASTRO INDUSTRIES INC	#1100V - 1060-ML		$3100	111
HOT ZONE DIMENSIONS		2.5 CM DIA. BY 15 CM LONG		
MAX SUSTAINED TEMP		1800 DEG C		
TIME TO TEMPERATURE		10 MINUTES MAX		
HEATING ELEMENT		MOLYBDENUM MESH WITH MOLYBDENUM SHEET RADIATION SHIELDS		
OPERATION ENVIRONMENTS		VACUUM, INERT GAS, AND REDUCING ATMOSPHERES		
OBSERVATION		SHUTTERED RADIAL VIEWPORT		
ACCESS		TOP AND/OR BOTTOM		
COOLING		WATER COOLED		

Figure 2-4. Sample from Commercial Equipment Shopping List

Space Division
Rockwell International

Four characteristics were considered to be significant for the equipment selected for analysis: (1) high procurement cost, (2) differing physical characteristics, (3) representation of many types of equipment, and (4) manufacture by a company willing to provide detailed data necessary for analysis.

The criterion stresses relatively more expensive experiment equipment items because they offer the greatest potential for savings to the Spacelab experiment program through the use of commercial equipment. Frequency of use and unit cost are combined in a single cost parameter to estimate a relative total program procurement cost for each item. For example, an item which costs five times more than another, but only used once, will have a smaller total procurement cost than a second item which is identified in ten different sortie payloads.

Representation of equipment built to different requirements is also desirable to assure identification of as many design issues as possible. At least one piece of equipment had to be selected from each SSPDA science and application discipline. In this way, hardware designs resulting from special functional requirements unique to a specific type of experimentation were examined. In addition to hardware built to commercial specifications, similar hardware built to aircraft and military specifications was selected to gain understanding of the design differences resulting from different specification requirements.

Equipment with differing physical characteristics was selected to assure examination of many design issues. Packages which are rack-mounted and others that are bench-mounted were selected. Integral and modular packaging techniques, such as those used by the nuclear instrumentation modules (NIM) and CAMAC, are represented. Equipment employing integrated circuits (IC's) and metal oxide on silicon-field effect transistors (MOS-FET) was identified to gain understanding of the suitability of hardware with technology more closely related to that of the Shuttle era.

Final selection of specific equipment items for analysis was based on the availability of manufacturer data. Similar studies have found that many manufacturers have not wished to provide data on their commercial equipment for either economic or competitive reasons. This selection criterion is a practical condition which assures the most complete information for the subsequent detailed analysis.

The approach employed to select hardware items for specific analysis is shown on Figure 2-5. The selection process had two phases. In the first phase equipment types were compared to determine which types would be best to analyze. During the second phase, specific available packages were identified for each selected equipment type which provided the broadest cross-section of design issues.

2.4.1 Equipment Selection Approach

Selection of the equipment for analysis was made from the 425 items in the shopping list by successively grouping and eliminating items with common characteristics. First, the list was condensed into 90 different types of hardware by grouping common equipment such as all receivers regardless of frequency band,

centrifuges regardless of speed, spectrometers and spectrophotometers regardless of spectrum band, etc. Next, these types were ranked according to relative procurement expense. Then, starting with the most expensive equipment type, the primary operating principle of successively less expensive types was compared. Less-expensive types with similar operating principles, such as electronic packages, were eliminated in favor of equipment with different operating principles such as optical or chemical analysis hardware. The representation of the resulting 25 types of equipment in each of the science and application disciplines was then validated to assure that at least one item from a payload in each discipline had been selected.

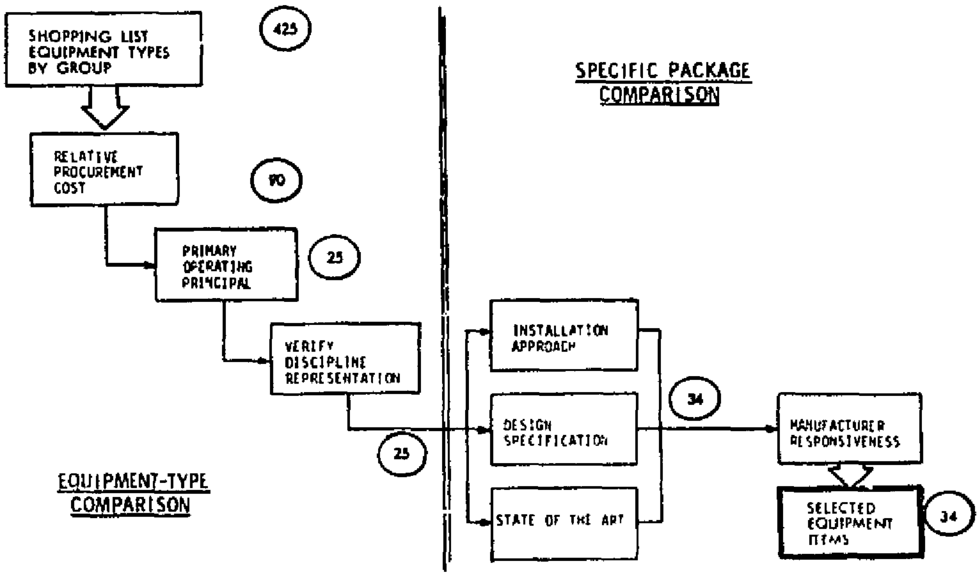

Figure 2-5. Equipment Selection Approach

The selected hardware group was increased to 34 to assure representation of different design characteristics. Additional items which were packaged as NIM (nuclear instrumentation modules) and ATR (air transport requirement or Austin Trumbull Radio) modules were added to commercial counterparts selected for a single equipment type to examine different installation approaches. Items which were representative of Mil-Spec and airborne specifications were also added to the commercially available units. Finally, selected advanced state-of-the-art hardware was added by the group.

The final group of selected hardware was changed slightly after soliciting information from the various manufacturers and determining which units were available for inspection. Twenty-nine out of 34 units were visually inspected, improving the depth of the suitability analysis.

2.4.1.1 Equipment-Type Comparison

Relative Procurement Cost. The quantity of each type of equipment estimated for the sortie experiment program and its retail cost was used to estimate the relative procurement cost for that item in the program. Equipment quantities identified in the functional requirements data bank were extended to the entire experiment program by applying the following ground rules and employing the payload flight schedule defined in the October 1973 mission model.

1. An equipment life of five years.

2. A single experiment module can be launched no more frequently than once every six months.

3. Hardware identified for one payload cannot be flown with another payload unless it was identified as core equipment.

4. A single piece of equipment cannot be used in more than one discipline. A duplicate must be purchased if requirements are identical.

The five-year life is based on technological change, cyclic life considerations, and the duration of the sortie experiment program. Technology changes in any five-year period are expected to make replacement of experiment equipment with improved hardware desirable. For a few items that historically have experienced rates of slow technology evolution, a lifetime greater than five years was assumed. Greater scientific benefit will be achieved per flight with improvements in equipment capability justifying such changes. Since the equipment is not initially built for space, a maximum of 10 cycles (one launch every 6 months for 5 years) through the launch-space-reentry environment was judged to be a reasonable goal. A lower number of cycles would emphasize equipment of payloads which have repeat flights. Since equipment components of repeat flights are not totally defined, over-emphasis might lead to improper equipment selection. Finally, a few sortie payloads fly for more than 10 years. Therefore, this ground rule generally requires at lease one replacement during the sortie experiment program. Such a replacement schedule would be expected in most cases under any circumstances. The estimation of equipment quantities appears in Volume III, Section 5.0.

An average six-month turnaround duration for refurbishment of Spacelab experiment modules is based on in-house studies of experiment integration activities[1]. This duration may be shorter for payloads which require little or no refurbishment, and longer for other payloads which have significant change-out or recalibration requirements (such as astronomy payloads). Six months is considered a fair average. A much shorter turnaround is envisioned for the Spacelab support module; however, it is assumed not to house experiment hardware.

[1] NAS1-12933, Spacelab User Implementation Assessment Study

Equipment identified for a given experiment module was assumed to remain with that experiment module for many reasons: (1) refurbishment of experiment modules will probably occur at many locations--making the shuttling of equipment packages a complex, costly logistics problem; (2) the cost of additional checkout and calibration activities caused by removal and reinstallation of hardware will be greater than the purchase ot an additional piece of hardware; and (3) the time spent for these additional integration activities would lengthen the turnaround time of experiment modules, possibly impacting the sortie experiment flight schedule. Similar logic applies to the use of the same hardware in different disciplines. Changeout complexities could be increased by minor modifications or accessories that may be particular to a discipline which are incompatible with another discipline.

Figure 2-6 shows an example of the determination of the relative procurement cost for a unit on board the Advanced Technology Laboratory (ATL). The October 1973 mission model shows that ATL flights occur throughout the 12 years of the mission model. A five-year equipment life study guideline requires that three sets of equipment be installed in the lab. Since a six-month turnaround time is required to refurbish each Spacelab experiment module, the ATL would require two experiment modules, doubling the equipment complement. A resultant total of six equipment sets are, therefore, needed in the ATL program.

OCTOBER 73 NASA MISSION MODEL

CY	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
ADVANCED TECHNOLOGY LAB	2	4	4	4	4	4	4	4	4	4	4	4	46

5-YEAR LIFE	1	1	1
6-MONTH TURNAROUND ADJUSTMENT	+1	+1	+1
EQUIPMENT SETS		6	
OSCILLOSCOPE		x 1	
TOTAL EQUIPMENT QUANTITY		6	
RETAIL COST RANGE		x 1K TO 3K	
RELATIVE PROCUREMENT COST FOR ATL PROGRAM		6K TO 18K	

Figure 2-6. Estimation of Relative Equipment Procurement Costs

The cost range for oscilloscopes needed on the ATL is then determined by multiplying the equipment sets (6) by the number of units on the ATL payloads (1), and by the retail cost range of that equipment ($1000 to $3000). Similar calculations would be made in other disciplines also using oscilloscopes. The sum total of these amounts would define the relative programmatic procurement cost for that item.

These total costs should not be interpreted as actual programmatic costs. Procurement costs will probably be much higher because of modifications or, in

some cases, custom-building the hardware. However, this approach employs costs from a common reference, retail costs, and therefore the relation of the equipment in the ranking is valid. The ranking is only intended as a selection tool and not as an indicator of the absolute magnitude of Spacelab equipment costs.

Since the selection criterion uses relative cost as a discriminator, the ranking of hardware by cost to the experiment program would not change significantly if aerospace costs, rather than retail costs, were used. Retail costs are an indication of complexity, state of the art, and production rate. Aerospace costs generally are estimated relative to state of the art and complexity. Manufacturing lot sizes are always small. Savings through mass production drives the retail cost of some items down lower than they would be on a relative scale based on low-production aerospace development costs. However, not many scientific instruments are mass-produced. Those that are, are used in sufficient quantities in the sortie experiment program to raise their total procurement cost and--as a result--their relative ranking. Also, since a significant number of equipment items will be selected, location in the ranking relative to individual items is not important--only an item's location within a segment of the ranking.

Table 2-3 lists the common equipment types ranked according to relative procurement cost. Highest rankings went to the equipment types which had the highest average relative procurement cost.

Primary Operating Principle. The number of equipment types of interest was reduced from 90 to 25 by comparing operating principles of the equipment and eliminating those that were similar. Table 2-3 illustrates this process. Starting with the most expensive units, units are selected until lower cost units which have similar design characteristics are identified. These similar units are passed over in favor of other units that cost less, but are representative of different operating principles. (Cameras are exceptions to this logic and are discussed later.) For example, a TV monitor was not selected because it has a CRT tube and electronic components similar to the previously selected keyboard/display terminal or the oscilloscope. The holographic imager is a device using optics and a laser to generate three-dimensional images. It was rejected because a laser had previously been selected. Similar logic was used on other items.

Still, cine and TV cameras were excluded from selection because commercial units have already flown in space. Hasselblad and Maurer cameras were used on Apollo and Skylab. A vidicon developed by RCA for space operations was also used and is available. Selecting alternative sources to these units and performing a suitability analysis on them would not yield any new information. Also, cameras are small enough to store in a protective container when not in use, reducing the need for significant modifications. Although they were not analyzed, their successful use in space indicates that available cameras can cost-effectively be employed on the Spacelab.

The resultant breakdown of basic design approaches used for the selected types is shown on Figure 2-7. Total representation exceeds the number of equipment types (25) because of dual representation by some types such as an

Table 2-3. Equipment-Type Selection

Item	Average Relative Procurement Cost ($K)	Selection Action	Rejection Rationale
Tape Recorders	1560	S	
Spectrometer/Spectrophotometer	840	S	
Lasers	720	S	
Computer	610	S	
TV Camera	570	R	Space-rated hardware available
Receivers	530	S	
Blood Cell Counters	380	S	
Spectrum/Wave Analyzers Frequency Generators	350	S	
Strip Chart Recorders/X-Y Plotters	290	S	
Cine Cameras	280	R	Space-rated hardware available
Keyboard/Display Terminal	242	S	
Gas Chromatograph/Gas Analyzers	220	S	
Transmitter	156	S	
Metabolic Analyzer	122	R	Similar to gas analyzers
Microscope	114	S	
Computer Input/Output Devices (A/D converters, amplifier, etc.)	106	S	
Oscilloscope	102	S	
Timer	69	S	
Volt Ohm Meter	64	S	
Signal Generator	63	R	Similar to spectrum analyzer
Electrophoresis	54.4	S	
Symbol Generator	47	R	Similar to previously selected electronics
Pyrometer	38	R	Small, easily protected, similar to selected optics
Accelerometer	35	R	Similar to previously selected electronics
Scanner Programmer	35	R	Similar to computer
Laser Optics	32.8	R	Similar to microscopes
Furnace/Oven	30	S	
Radiation Sources	30	R	Buy as delivered from AEC
Dewar	27.6	S	
Photo Processor	25	R	Similar to laser
Incubator	24	R	Similar to ovens
TV Display	24	R	Similar to keyboard/display
Power Supply/Conditioner	22	S	
Refrigerator/Freezer	20	S	
Lyophilization Unit	19	R	Similar to refrigerator
Acoustic Transducer	16	R	Similar to previously selected electronics
Optical Particle Detector	14.5	R	Similar to spectrophotometer
Still Camera	14	R	Space-rated hardware available
Bandpass Filter	13.7	R	Similar to previously selected electronics
Centrifuge	13.5	S	
Blood Circulation Instrumentation	13.2	R	Similar to previously selected electronics
Radiation Counter	13	S	
Physiological Monitor	12.4	R	Similar to previously selected electronics
Microfilm Viewer	12	R	Similar construction to strip chart recorder
Power Meter	11	R	Similar to previously selected electronics
Microtome	7.4	S	
Acoustic Generator	7.2	R	Similar to power supply
pH Meter	5.9	S	
Compressor/Pumps	5	R	Similar to centrifuge

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electrophoresis device which is electro-chemical. The preponderance of electrical equipment is representative of the distribution of equipment types in the various sortie laboratories. Electronic instrumentation is prevalent in all the laboratories. Representation of the other technology areas is adequate to understand their associated design issues.

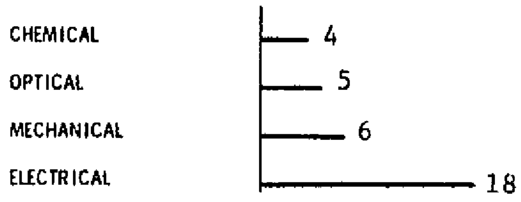

Figure 2-7. Equipment-Type Primary Operating Principle

Science and Application Discipline Representation. The selection criteria required selection of at least one unit from each discipline. The selection approach tends to emphasize those items which are needed in significant quantities and, as a result, the selected items are identified in more than one discipline. Figure 2-8 shows that each discipline is represented by at least five selected units reflecting this cross-discipline representation.

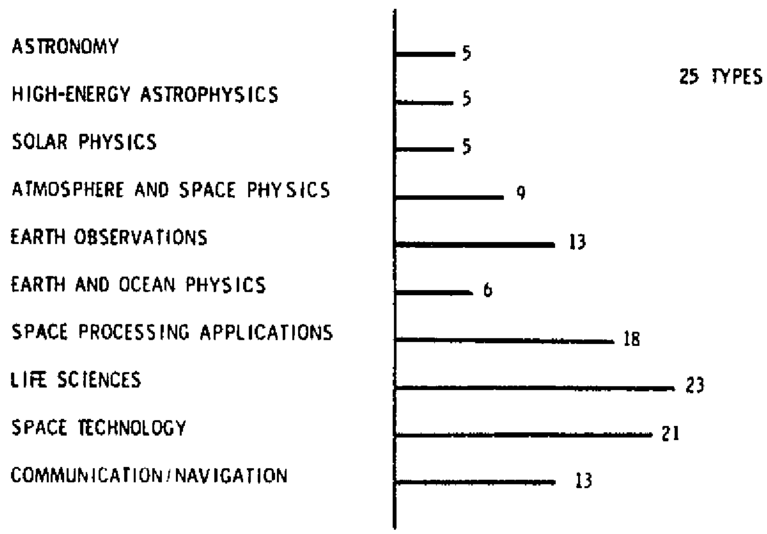

Figure 2-8. Discipline Representation

The quantities identified for each discipline reflect the general location of experiment equipment in that discipline. The experiment equipment of the Astronomy, High-Energy Astrophysics and Solar Physics disciplines are located on the pallet. The pressurized module acts only as a control center and as a result only contains core-type support hardware. Therefore, the representation of equipment from these disciplines is understandably low. Many experiments are performed in the Spacelab in the Space Processing, Space Technology and Life Sciences disciplines. In the case of Life Sciences, all are internal.

This discipline also has the greatest potential for using commercial equipment because its instrumentation requirements are frequently the same as those on the ground. Space Technology has high representation because its experiments are similar to those in Earth Observations, Life Sciences, and Communication/Navigation disciplines which are well represented.

2.4.1.2 Specific Package Comparison

Table 2-4 lists the selected equipment types and the specific available units that were analyzed for their suitability to space operations. Also shown is the representation of the selected units with respect to the selection criteria.

Design Characteristics Representation. Hardware was selected that provided broad representation of available hardware. Units were selected from firms that were leaders in their industry such as Beckman for biomedical instrumentation, Tektronix and Hewlett-Packard for electronic instrumentation, Clay-Adams for centrifuges, and American Optical for microscopes. Other units were selected because other sortie payload studies identified them as suitable for Spacelab operations, such as the Astro furnace. Still others were selected because they displayed design issues of interest. To achieve such representation, more than one available unit was selected for certain equipment types. For example, a NIM-type timer by Tennelec was selected along with the 19-inch rack-mounted Datatron timer. In another case, both commercial and mil-spec volt/ohm meters were selected. Additions such as these caused the final number of items for analysis to increase from 25 to 34.

Representation of different design specifications by the selected hardware is shown graphically in Figure 2-9. Available airborne equipment applicable to this study is limited to recorders, computers, signal conditioners, receivers and transmitters, leading to the low representation of this type of hardware. Three airborne units were selected. Selection of the Ampex AR700 occurred because it was not only an airborne unit, but it was the specific model that was modified by Martin Company for use on the Skylab. Selection of an airborne receiver and a transmitter was natural because of the availability of this type of hardware. The Mil-Spec units represent varying degrees of Mil-Spec design. The Fluke DVM and the Hewlett-Packard oscilloscope are more rugged than the Singer unit and the Fluke spectrum analyzer. The former units are designed for field use which accounts for the ruggedness of their designs. If the Army Field Medical Laboratory[1] effort ever moves into the hardware phase, additional Mil-Spec units in the biomedical field will be available to Spacelab.

Packaging approaches of the selected hardware include ATR, NIM, and conventional bench- and rack-mounted configurations. The distribution of the different configurations is shown in Figure 2-10. Many airborne units can be obtained as ATR modules. Of the three airborne units selected, the Collins receiver and the RHG transmitter were of this configuration. NIM configuration equipment appears limited to nuclear-related and computer-related hardware. In addition to the particle counter, the timer, and the analog-to-digital converter, a NIM bin power

[1]SID 67-269, Phase II, Army Field Medical Laboratory Program, Phase II, Laboratory Feasibility Equipment Evaluation and Development Data Systems Study Report, Rockwell, 2/28/67

Space Division
Rockwell International

Table 2-4. Selected Equipment Representation Summary

EQUIPMENT-TYPE COMPARISON

Equipment Type	Discipline Representation: Astronomy	High-Energy Physics	Solar Physics	Atmosphere and Space Physics	Earth Observations	Earth and Ocean Physics	Space Processing	Life Sciences	Space Technology	Communication/Navigation	Operating Principle Representation: Chemical	Electrical	Mechanical	Optical
Tape Recorder	X	X	X	X	X	X	X	X	X	X		X	X	
Computer	X	X	X	X	X	X	X	X	X	X		X		
Keyboard/Display Terminal	X	X	X	X	X	X	X	X	X	X		X		
Blood Cell Counter								X	X		X	X		X
Timer	X	X	X	X	X	X	X	X	X	X		X		
Spectrometer, Spectrophotometer					X	X	X	X	X		X			X
Receiver/Transceiver								X	X	X		X		
Transmitter				X				X		X		X		
Signal Conditioners (Amplifiers, A/D Converters, etc.)	X	X	X	X	X	X	X	X	X	X		X		
Spectrum Wave Analyzers Frequency Generators				X	X			X	X	X		X		
Laser Assembly					X		X		X	X		X		X
Gas Chromatograph, Gas Analyzer							X	X	X		X	X		
Microscope					X			X	X					X
Strip Chart Recorder, XY Plotters				X			X	X	X	X		X		
Volt/Ohm Meter							X	X		X		X		
Oscilloscope				X	X		X	X	X	X		X		
Electrophoresis Apparatus							X	X	X		X	X		
Furnace/Oven							X	X					X	
Dewar					X		X	X	X				X	
Power Supply					X		X		X	X		X		
Centrifuge								X	X				X	
Refrigerator Freezer							X	X	X				X	
Particle Counter Assembly					X		X	X				X		
Microtome								X					X	
pH Meter							X	X			X	X		

SPECIFIC PACKAGE COMPARISON

Equipment Type	Manufacturer	Model Number	Design Characteristics: Design Spec: Commercial	Airborne	Mil-Spec	Package Config.: ATR	[illegible]	Bench	State Of The Art: [illegible]	[illegible]	Current
Tape Recorder	Ampex	AR700		X						X	
	Honeywell	5600	X							X	
Computer	Digital Equipment	PDP-8e	X								
Keyboard/Display Terminal	Research, Inc.	3311RN	X								
Blood Cell Counter	Coulter Electronics	Fn	X					X			
Timer	Datatron	3150	X							X	
	Tennelec	TC545	X				X				
Spectrometer, Spectrophotometer	Beckman	24	X					X			
Receiver/Transceiver	Singer	NM37/57			X				X		
	Collins Radio	618M-2		X		X					
Transmitter	RHG	W1900		X		X				X	
Signal Conditioners (Amplifiers, A/D Converters, etc.)	Neff	126	X						X		
Spectrum Wave Analyzers Frequency Generators	Nuclear Data	ND100	X				X			X	
	Hewlett-Packard	141T/8552/8555/8445	X								
	Singer	558 50-1L			X						
	Fluke	645M			X						
Laser Assembly	Sylvania	948	X					X		X	
Gas Chromatograph, Gas Analyzer	Beckman	6700	X					X			
Microscope	American Optical	XH20TGQW	X					X			X
Strip Chart Recorder, XY Plotters	Honeywell	1858	X						X	X	
Volt/Ohm Meter	Fluke	8700A	X						X	X	
	Fluke	8125A			X			X		X	
Oscilloscope	Tektronix	485	X						X	X	
	Hewlett-Packard	AN/USM-281A			X			X			X
Electrophoresis Apparatus	Beckman	R-100	X					X			X
Furnace/Oven	Astro	1000A	X					X			X
Dewar	Cryogenic Associates	SR-90	X					X			
Power Supply	Sorenson Div. of Raytheon	SLR40-12	X						X		
	Power Designs	AEC320-3	X				X				
Centrifuge	Clay Adams	CT1004	X					X			X
Refrigerator Freezer	Revco	ULT-185A	X					X			X
Particle Counter Assembly	Ortec	401/TC611/435/410	X				X			X	
Microtome	American Optical	820	X					X			X
pH Meter	Beckman	PHASAR I	X					X			X

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supply was selected so that the major elements of the NIM system could be better understood. CAMAC hardware was not selected, but its packaging approach is similar to the NIM approach. The remaining units were either bench- or rack-mounted. Most of the electronic packages can be obtained in a 19-inch EIA rack-compatible configuration. NIM hardware is also compatible with 19-inch racks. The ruggedized military units made for field use are exceptions to this generalization and are not available in a rack-mounted configuration.

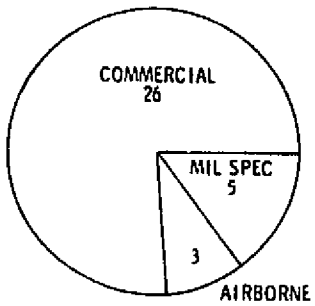

Figure 2-9.
Design Specification
Representation

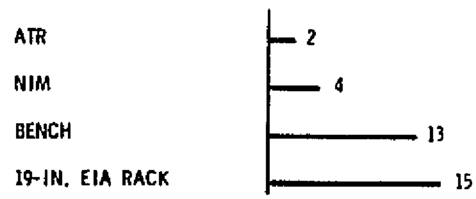

Figure 2-10.
Package Installation
Configuration Representation

The selected hardware displayed a good balance of current and advanced technology as shown in Figure 2-11. The term "advanced technology" requires interpretation since any available hardware could be classed as current by the mere fact that it is available. Components that are representative of the hardware expected to exist during the Shuttle era are advanced state-of-the-art units which utilized integrated circuits, MOS-FET devices, laser and fiberoptics for light transmission. Units selected for these advanced characteristics included the Research Incorporated display terminal which makes extensive use of integrated circuit chips, the Neff amplifer which employs MOS-FET devices, and the Honeywell strip chart recorder which replaces the typical pen/galvanometer marker with transmission of a CRT image by fiberoptics into photosensitive paper.

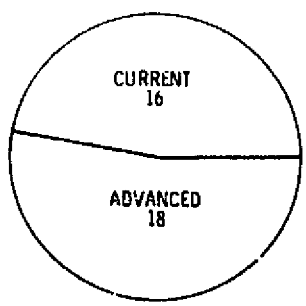

Figure 2-11. State-Of-The-Art Representation

Availability for Inspection. Final selection of model number also hinged upon the availability of hardware for inspection. Contact with suppliers was, in general, good. Many brought demonstrator units into Space Division and allowed the team to dismantle and photograph them. In other cases, the hardware was not available for inspection on the west coast. The model number was either changed or the suitability analysis had to rely only upon available specification data.

Hardware inspection was achieved on 29 of 34 items. Two activities contributed significantly to this high success ratio. First, the capital equipment tabulations of all Rockwell divisions in the Los Angeles area were consulted to identify selected hardware owned by this company which the team was assured of examining. Seven units were identified from this search and later examined. Second, a tour of the Beckman Instruments facilities yielded even better results. Nine more units were inspected at the Beckman plant. One unit in particular, the Coulter blood cell counter, could not have been inspected if Beckman had not had one in their laboratories. Contacts with Coulter Electronics had not been successful. When talking to the president of the company he recommended that we buy a unit if we wanted to inspect it. This type of response was not typical of the manufacturers and sales representatives contacted by the study team.

2.5 CONCLUSIONS FROM EQUIPMENT SELECTION ACTIVITY

The three major achievements of the equipment identification and selection activity were: (1) the generation of a functional requirements data bank documenting the equipment requirements for all internally located equipment identified in the sortie science and application disciplines; (2) development of a shopping list identifying available hardware that meets these functional requirements; and (3) selection of 34 items from the shopping list for suitability analysis.

During this effort, one conclusion was reached which is significant to the use of available hardware in space. Approximately 60 percent of the experiment equipment requirements of Spacelab could be satisfied by available hardware. Further study of available hardware catalogs might increase this percentage even highter. There is such a wide variety of equipment available that the requirements of the Spacelab hardware usually can be achieved by some supplier. This fact should encourage NASA and principal investigators to examine catalogs of available hardware to satisfy experiment requirements before initiating a program to custom build specialized hardware for Spacelab experiments.

3.0 ANALYSIS OF SELECTED EQUIPMENT

3.1 INTRODUCTION

This section presents the suitability and cost analysis for the 34 selected equipment items identified in the previous section. Equipment characteristics were compared to Spacelab interface requirements to identify incompatibilities. Modifications were defined to correct these incompatibilities and the cost of these modifications were estimated. The costing of custom procurement of the same equipment is also described. The costs of the two alternatives were compared in order to determine if off-the-shelf experiment equipment is cost effective for Spacelab applications.

Figure 3-1 illustrates the analytical approach employed. The baseline criteria for the modification and costing are provided by a Spacelab/Experiment Equipment Interface Requirements (SEEIR) document specially generated for this study. This document reflects a policy of minimum NASA/Spacelab involvement with the experimenter prior to placement of the equipment on board Spacelab. The SEEIR document is included as Appendix D to this volume. Further discussion of rationale behind the document is presented in Section 3.2.2.

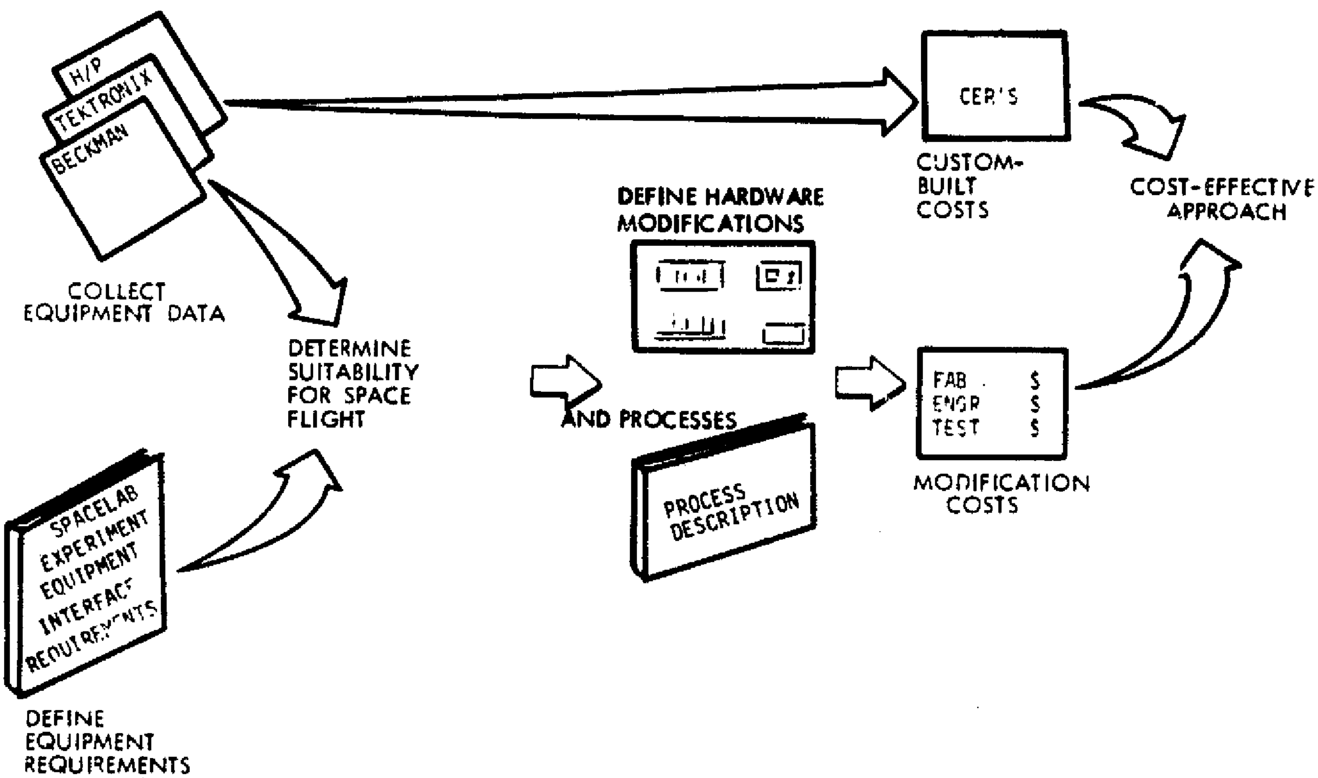

Figure 3-1. Logic Flow Diagram for the Analysis of Selected Equipment

The SEEIR criteria plus a set of standard design guidelines were established to a level of detail adequate to discern significant unsuitable design features and define acceptable solutions for the selected units. Suitability was determined from a combination of visual inspection of the equipment items and available data from catalogs, maintenance manuals, and responses by suppliers to questions. Basic suitability and specific unsuitabilities were uniformly determined by using the same engineering team for all items. Where logical, similar design modifications were defined for common unsuitable characteristics in order to arrive at consistent cost impacts. The suitability analysis and design guidelines are described in more detail in Section 3.2, and the modifications and results are covered in Section 3.3.

A "grass roots" cost estimating procedure was employed to establish modification costs. Experienced instrument manufacturing personnel from Beckman Instruments provided fabrication costs based upon current manufacturing practices. Rockwell and Beckman collaborated in developing standards for engineering and test costs. These costs, along with documentation and project management cost, defined the total modification cost for each item. The costing of custom-procured hardware employs traditional techniques of cost estimating. Cost estimating relationships (CER's), applicable to particular types of equipment, were utilized to estimate procurement costs. The cost analysis effort is described in detail in Section 3.4.

3.2 SUITABILITY ANALYSIS

3.2.1 Approach

The basic approach to evaluating the 34 selected items of equipment relied heavily upon visual inspection of the equipment items. Twenty-nine of the 34 items were visually inspected. All covers, subassemblies, etc., were removed to observe pertinent design features. Criteria checklists and reference to standard design guidelines that reflect acceptable solutions to various SEEIR criteria were used to evaluate each item for acceptance and shortcomings.

Table 3-1 summarizes the suitability and cost analysis activities for each equipment item. All items inspected, except the ND-100 multichannel analyzer, were photographed to show overall construction as well as to highlight features judged inadequate to meet SEEIR criteria. The photographs were referred to throughout the study for modification definition and costing. The RHG transmitter was not available for physical inspection, but the manufacturer provided internal pictures of it and similar units to illustrate its construction. Published data such as specifications, maintenance manuals and operations manuals were acquired to aid judgment on adequacy of design. Also, the counsel of other technical personnel engaged in testing or design on other hardware programs was sought to help verify judgmental standards. This was particularly true in the areas of vibration and material usage.

Information was collected on checklist work sheets similar to that shown by Figure 3-2. The acceptability, uncertain acceptability, or unacceptability of each equipment characteristic was checked on the work sheet and amplifying

Table 3-1. Summary of Activities For Each Selected Item

Item		Pictures	Data	Inspection	Modification Definition	Modification Design	Fabrication Cost	Total Mod Cost	Custom Cost	Cost Comparison
AMPEX	AR700	X	X	X	X	X	X	X	X	X
HONEYWELL	5600	X	X	X	X	X	X	X	X	X
DIGITAL EQUIPMENT	PDP8	X	X	X	X	X	X	X	X	X
RESEARCH	3311RN	X	X	X	X	X	X	X	X	X
COULTER	Fn	X	X	X	X	0	0	0	X	0
DATATRON	3150	X	X	X	X	X	X	X	X	X
TENNELEC	TC545	X	X	X	X	X	X	X	X	X
BECKMAN	24	X	X	X	X	X	X	X	X	X
SINGER	NM37/57	X	X	X	X	X	X	X	X	X
RHG	W1900	X	X	0	X	X	X	X	X	X
COLLINS	618M-2	X	X	X	X	X	X	X	X	X
NEFF	126	X	X	X	X	X	X	X	X	X
NUCLEAR DATA	100	0	X	X	X	X	X	X	X	X
HEWLETT-PACKARD	141T	X	X	X	X	X	X	X	X	X
SINGER	SSB 50-IL	(1)	X	0	X	X	X	X	X	X
FLUKE	645M	(1)	X	0	X	X	X	X	X	X
SYLVANIA	948	X	X	X	X	X	X	X	X	X
BECKMAN	6700	X	X	X	X	X	X	X	X	X
AMERICAN OPTICAL	H20	X	X	X	X	X	X	X	X	X
HONEYWELL	1858	X	X	X	X	X	X	X	X	X
FLUKE	8200	X	X	X	X	X	X	X	X	X
FLUKE	8125	(1)	X	0	X	X	X	X	X	X
TEKTRONIX	485	X	X	X	X	X	X	X	X	X
H/P	AN/USM	0	X	0	X	X	X	X	X	X
BECKMAN	R	X	X	X	X	X	X	X	X	X
ASTRO	1000	X	X	X	X	X	X	X	X	X
CRYO ASSOC.	LR90	X	X	X	0	0	0	0	X	0
SORENSEN	SLR40	X	X	X	X	X	X	X	X	X
POWER DESIGN	AEC320-3	X	X	X	X	X	X	X	X	X
CLAY ADAMS	CT1004	X	X	X	X	X	X	X	X	X
REVCO	ULT185	X	X	X	0	0	0	0	X	0
ORTEC	401	X	X	X	X	X	X	X	X	X
AMERICAN OPT	820	X	X	X	X	X	X	X	X	X
BECKMAN	Phasar I	X	X	X	X	X	X	X	X	X

(1) Pictures available in maintenance manuals or other data.
0 No activity.

COMMERCIAL EQUIPMENT EVALUATION SUMMARY SHEET
FOR INDIVIDUAL UTILIZATIONS IN SPACELAB

Name: ______________ Model: ____________ Company: ______________ __________

Feature	No Information	Source: Literature	Source: Inspection	Acceptable	Acceptable--Verification Required	Unacceptable	Comment
I CONSTRUCTION							
A. Shatterables (with release restraints)							
B. 9-G mounting/integrity							
C. Protrusions and edges safety							
D. 19-inch rack mount capability							
E. Shock-vib-accel-acoustics resistance							
F. Depressur. hazard suppression							
G. EMI generation suppression							
H. EMI susceptibility protection							
II MATERIALS USAGE							
A. Fiaking and peeling resistance							
B. Concentrations of flammable/ unidentified materials							
C. Non-prevelant commercial materials (or warnings on handling/usage of item)							
D. Resistance to combustion ignition							
III INPUT POWER COMPATIBILITY							
IV THERMAL COMPATIBILITY							
V DATA SYSTEM COMPATIBILITY							
VI ATMOS. CONTAM. RLSISTANCE							
VII ZERO-G OPERABILITY							
A. Human factors							
B. Functional operation							
C. Loose parts/constraints							
VIII AUDIBLE NOISE							

Figure 3-2. Typical Evaluation Summary Sheet

remarks added as inspections and data evaluations were made. General modification requirement summary sheets were then prepared from the checklist data and from other data relating to peculiar requirements not covered by the general checklist. A sample modification requirements summary sheet is shown in Figure 3-3. In general, a conservative approach for costing purposes was taken by assuming the need for modifications where a reasonable doubt of suitability existed, as well as for design characteristics that were clearly unacceptable. Testing of these items would resolve the uncertainties. These modification summary sheets were used by design engineers to select standard modifications or to define any necessary unique designs as needed for realistic costing.

This same process was essentially repeated, using the same photographs and data accumulated in this task, to determine the delta modification requirements to implement the current version of NASA Equipment Specification EC006M00000A. The EC006M evaluation is described in Section 4.0.

MODIFICATION REQUIREMENTS SUMMARY
FOR
TENNELEC COUNTER (NIM ASSY) - TC545A Counter/Timer
(Excludes Nuclear Detector) - TC216 Linear Amp/Set
- TC909 Power Supply

A. Provide 0.5-in. min. radii guard on NIM bin to prevent bodily contact with panel controls.*

B. Vibration Protection (shockmount, worst axes random plus sine specs):
   1. Stiffen/support TC545 and TC216 circuit boards from excessive deflection (oil canning).
   2. Support/stiffen lead-mounted parts, such as ceramic capacitors, on circuit boards to prevent fatigue bending.
   3. Support end-mounted trimpots in TC545 and TC216.
   4. Support large lead-mounted capacitors in the TC909.
   5. Tie wires/bundles to prevent fatigue bending at connections (3 modules); see photos.
   6. Push-on transistor heat dissipators (2 in TC909) from loosening.
   7. Screws, knobs, thumbscrews from backing out (3 modules).

C. Bake out for equivalent 150 hours operation to expel surface gases (3 modules).

D. Provide flame retardant for unidentified organic electronic part materials on circuit board and circuit board itself (3 modules).**

*Assume that a 19-in. rack mount bin will be used in place of the portable unit inspected.

**Wiring is TFE per Tennelec rep. (Shuttle rated A for flammability and offgassing)

Figure 3-3. Example Copy Of A Typical SEEIR Modification Summary Sheet

3.2.2 Spacelab/Experiment Equipment Interface Requirements (SEEIR) Document

3.2.2.1 Document Use

In order to evaluate the selected equipment for suitability, it was necessary to have evaluation criteria available. Such criteria had to be at a level of detail to permit the analysis of specific designs of a wide range of functional equipment items. The Spacelab/Experiment Equipment Interface Requirements Specification was developed to fill this need. As the study progressed, the need for still more definition of acceptable design practice became necessary in order to assure costing consistency. The SEEIR design evaluation/acceptance interpretations were used to fill the need. Areas for further study have been identified in many sections. The results of these studies could be incorporated into the SEEIR at some future date.

The use of the current version of the SEEIR, for purposes other than this study, should be tempered by the fact that many of the cited values will probably change as a result of continuing Spacelab design definition. Also, a number of engineering judgments were needed to resolve source data that were incomplete or in conflict. More justification and analysis may be warranted to support these derived requirements.

3.2.2.2 SEEIR Document Basic Philosophy

The basic philosophy for the SEEIR document was to minimize the cost of experiment hardware by transferring the responsibility of successful equipment operation to the principal investigator (PI), recognizing however that some aspects of safety and experiment environment could not be readily compromised. The intent is to take advantage of the benign environment existent in the Spacelab and acknowledge exposure to typical, rather than worst case, ground environments in order to maximize the potential use of commercial equipment designs.

The PI would be responsible for assuring NASA that his equipment met safety requirements and his operational objectives. NASA would supervise nominal integrated tests and inspections, prior to taking the equipment on board Spacelab to verify that hazards or interferences to other Spacelab equipment do not exist. Savings could accrue to the PI and NASA by minimizing NASA involvement in such areas as program plans, design reviews, coordination/approvals, data generation and review and demonstration tests. Reliability, maintainability and other assurances would be consistent with the PI's success objective, the scheduled reuse of equipment and between-flight refurbishment capabilities.

The SEEIR is a first step toward a Spacelab experiment equipment specification. Its intended use was only as an aid to the suitability analysis performed in this study. If the SEEIR is used as a basis for the final NASA experiment equipment specification, further investigation is needed to define the mandatory assurance testing and inspections for various categories of equipment in order to achieve adequate safety confidence at low cost. Additional investigations in the following areas are also recommended: generation of simplified vibration requirements, development of a design evaluation "cook book" for experimenters/designers, and definition of precise criteria for acceptance of unidentified materials or conditional flammables/toxins.

Data sources are listed in the Applicable Documents section (paragraph 2.0) of the SEEIR. The original SEEIR document was updated on the basis of the Spacelab Systems Requirements document of the ESRO RFP when it became available. A primary source of detailed environmental criteria was the ERNO Preliminary Spacelab Design Specifications (December 1973). The vibration specifications, in particular, are relatively severe for typical commercial equipment and should be reviewed and updated to the most recent design predictions in any subsequent uses of the SEEIR document. Shuttle program documents were used to define acceptable materials. A SEEIR update should include more direct reference to general application NASA documents. The role of source documents used for SEEIR is covered further in the following discussions of the detailed rationale behind some of the more critical criteria.

3.2.2.3 General SEEIR Contents and Organization

Figure 3-4 depicts the key contents and organization of the SEEIR. The specification mainly addresses the topics listed in the central triangular region of the diagram. These topics are covered in two sections. The first section defines the Spacelab capabilities and requirements, which can be categorized into three main groups: safety, environments and equipment support capability. The second section comprises the actual experiment equipment requirements. The latter can be categorized as those requirements that impact Spacelab safety and environmental preservation requirements, and those that are necessary only to contend with the Spacelab-provided environment and support.

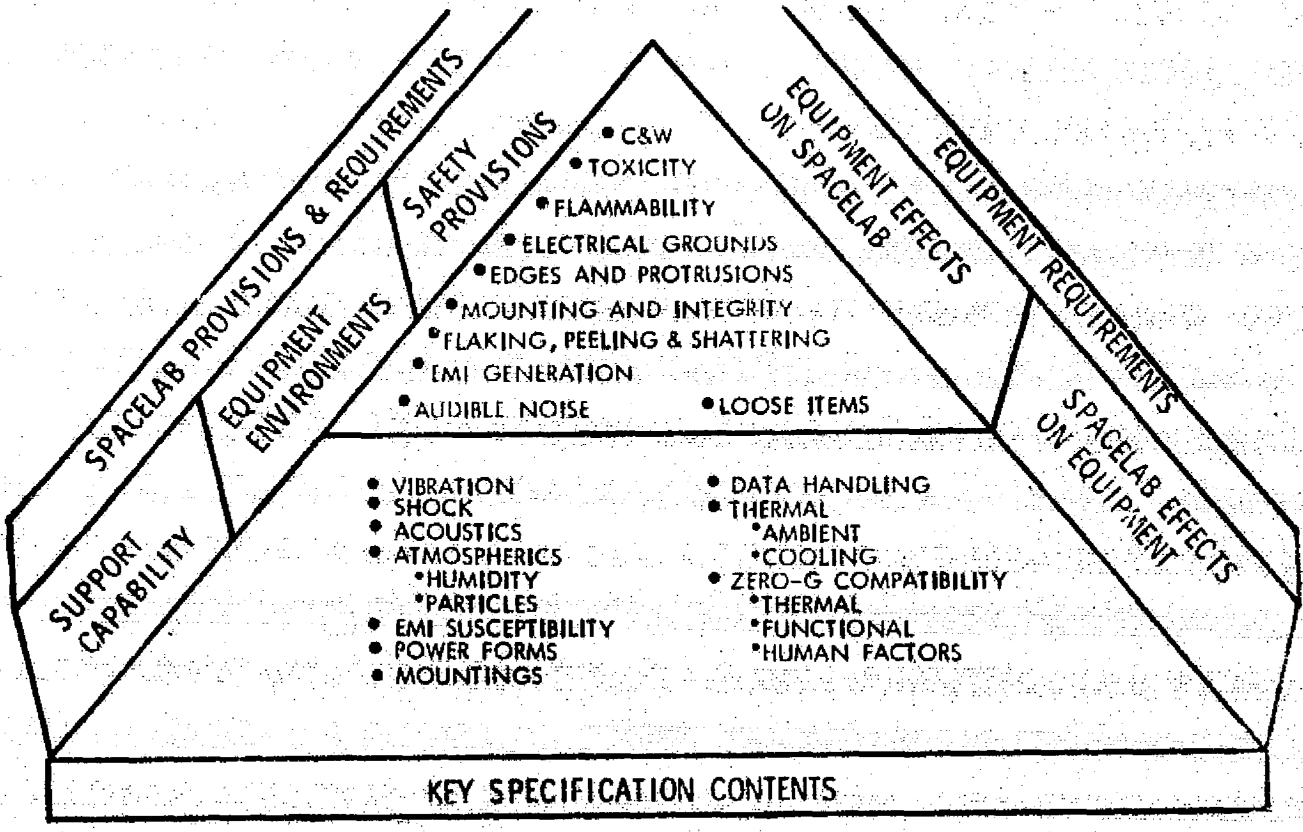

Figure 3-4. Interface Specification Description
Key Contents and Organization

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Equipment requirements that impact Spacelab requirements are considered mandatory. Other requirements are necessary for experiment success, but do not affect the integrity of the Spacelab.

The first section of SEEIR documents Spacelab characteristics. Experiment equipment requirements derived from these characteristics are placed in the latter part of the document. In many cases the equipment requirements, such as environments, are identical to Spacelab design capability, and hence, merely refer to applicable Spacelab requirements. In other cases, the equipment requirement may need more detail, or represent an allocation of the Spacelab total support capability.

3.2.2.4 Explanation of Specified Requirements

This section discusses the sources of data, problems, assumptions, rationale, use and selection of specific experiment equipment requirements that make up the SEEIR. Requirements can be conveniently categorized as safety provisions, equipment environments, and support capability. The discussion has been organized by key topics rather than by specification paragraphs. Pertinent subparagraphs under 3.1.1, Spacelab Design Characteristics and 3.2, Experimenter Equipment/Materials Requirements, of the SEEIR document are covered where significant issues may be involved.

3.2.2.4.1 Safety Provisions

Caution and Warning (C&W). The ESRO Spacelab RFP requires C&W for all potential hazards that may develop during the mission. The ERNO Spacelab studies and design data provide audio and visual display of caution and warning conditions. Independent emergency power for C&W is indicated. Each item will be evaluated for hazards and unique C&W needs. Functional failure of most experiment equipment items will not generally affect Spacelab operation. Hazards such as fire or leakage can be handled by "tack-on" sensors and integrated logic converters. In most cases sensors could be attached to the mounting rack or equipment exterior when prudent to augment overall Spacelab sensor systems. More definitive study is suggested to develop ground rules for providing necessary Spacelab C&W with a minimum of impact on experiment equipment and also to define those conditions where experiment equipment must provide specific design for C&W.

Flammability-Toxicity-Outgassing. The allowable materials listing from the Shuttle program was used to judge whether known materials were acceptable with respect to flammability, toxicity and outgassing for an air atmosphere. Mercury, cadmium and methyl chloroform were prohibited for any use based upon consultation with in-house materials experts.

All constituent materials could not be precisely identified for the equipment analyzed. However, it was concluded that the risk of dangerous quantities of toxics is minimal for off-the-shelf items in extensive use. Occupational Safety and Health Administration Act (OSHA) requirements, military specifications and accumulated experience make similar components acceptable for home, factory or laboratory. These same specifications reduce the risk to Spacelab inhabitants from materials in available equipment. However, since outgassing and flammability are rigid safety issues, all unidentifiable materials are assumed to be flammable. Threshold limits for chemical contaminants quoted in the specification were originally developed for the Space Station Phase B study and repeated in ERNO documentation. All wiring and PVC-appearing plastics are assumed to be PVC and flammable if not identified as a nonflammable such as TFE, phenolic epoxy, etc., which are approved by Shuttle. Circuit boards are coated with an impermeable film to prevent outgassing and fire. Typical electronic components are assumed acceptable without specific materials identification when in totally enclosed containers, preventing migration of air to support combustion, excepting certain parts/materials which are specifically prohibited such as mercury, cadmium, etc. The prohibited parts would be easily identified with the aid of cook-book rules to be providied (i.e., lamp bulbs and nixie tubes may contain mercury and must be replaced, etc.). Where deemed necessary, it is assumed that fire-retardant encapsulants could be applied. Cadmium-coated chassis are prohibited. It is assumed that unidentified materials could sputter flaming particles, therefore, screened or solid enclosures or fire-retardant encapsulation is required where ignition is possible. Combustible paths to points external to the case are to be eliminated.

One-hundred percent material identification is not required by the specification. Justification for not requiring 100-percent materials identification is strengthened where fused circuits and low-circuit voltages essentially eliminate short-circuit fire ignition. The precautions of conformal coating and 150-hour bakeout reduce hazards to an acceptable level. Metal enclosures, further enhanced by rack metal barriers, minimizing the potential for external ignition, provide added justification.

To reduce the hazard from trace gas contamination, it was decided, accordingly, to require a 150-hour equivalent operational bakeout to drive off surface gases and volatile heavy organics. The effectiveness of this process would be verified during Spacelab integration tests. Periodic gas samples from the bakeout chamber are recommended to assure that the volatiles driven off have dropped to an acceptable level after 150 hours. Longer durations may be necessary in a few cases. Elevated temperature and/or reduced atmospheric pressures could be utilized to expedite the process.

While the rationale for the SEEIR appears reasonable, a study effort for a more detailed analysis and documentation of rules and requirements is suggested. Cadmium-plated chassis (coated or uncoated) may, in fact, be acceptable--at least within enclosed/protected containers--and/or where credible ignition sources do not exist.

Electrical Grounds. Prevention of electrical shock from normally accessible surfaces, whether from static electricity or faulty circuits, is mandatory. Such control is consistent with 1970 OSHA standards. Compliance must also satisfy EMI control requirements for signal and case grounds.

Edges and Protrusions. The ERNO preliminary design data require 0.5-inch radii on edges and corners and no dangerous protrusions (presumably in travel lanes). This criterion for equivalent protective guards was adopted for SEEIR. Other source data suggested that a lesser radii may be tolerated. However, for this study the lesser radii would have little effect on cost estimates.

Mounting Integrity-Loose Items. Shuttle documentation indicates a maximum 9-g crash load on item mounting and integrity (i.e., no loose parts may become projectiles) in the +X direction. ERNO data also indicate up to 14 g rms (20 to 2000 Hz) random plus up to 3-g peak sinusoidal vibration for launch/reentry conditions for hard-mounted (to Spacelab) items. Up to 4.4 g rms (20 to 2000 Hz) random plus 3-g peak sinusoidal is stated for shock-mounted items. Since this was the only definitive data available it was accepted as baseline.

Loose items in Spacelab that might cause short circuits, injury, discomfort, inconvenience or damage were precluded. These include items that could come loose in a 9-g crash or "float" about in zero-g as a result of prior exposure to vibration. Chassis and part-mounting screws, thumbscrews, control panel knobs, door latches, and connector matings were reviewed to assure that they withstand both vibration and acceleration loading.

Touch-Temperature. The ESRO RFP and other data indicate that touch-surfaces should not exceed 115 F, which was accepted as baseline. Some MIL specifications, such as MIL-STD-1472A, allow 120 F (for handling) versus 140 F (inadvertent). The selected value was the most conservative and is consistent with other manned space programs.

3.2.2.4.2 Equipment Environments

Flaking-Peeling-Shattering. The ESRO RFP and ERNO documents site a Class 100,000 cleanliness environment for Spacelab on the ground, with 5-micron filtering subsequent to launch. Consistent with this requirement, internal and external surface coatings must be free of visual evidence of flaking or peeling. A more stringent requirement was unnecessary due to the relatively short mission duration in which degradation may take place.

A more critical requirement is to prevent shatterables (such as glass) from getting into the Spacelab atmosphere. This would include glass nixie and CRT tubes and fuses inside an item that could break for any reason and escape through holes in the case. An unresolved issue is the micron size and kinds of shattered particles and/or quantities that can be tolerated. Sealing or screening of case openings involves secondary impacts on thermal air-flow cooling. Within the range of uncertainty on allowable escape sizes, the modification costs would not vary significantly, precluding a need for detailed analysis of optimum mesh sizes.

EMI Generation. Extensive criteria in ERNO, ESRO RFP, MIL-I-6181D, MIL-STD-461 and -462, MSFC SL-E-001 and -002, and various spacecraft programs documents were reviewed. Satisfactory EMI control is historically difficult to achieve without fixes during verification tests, often because various shielding and circuit isolation rules are not followed.

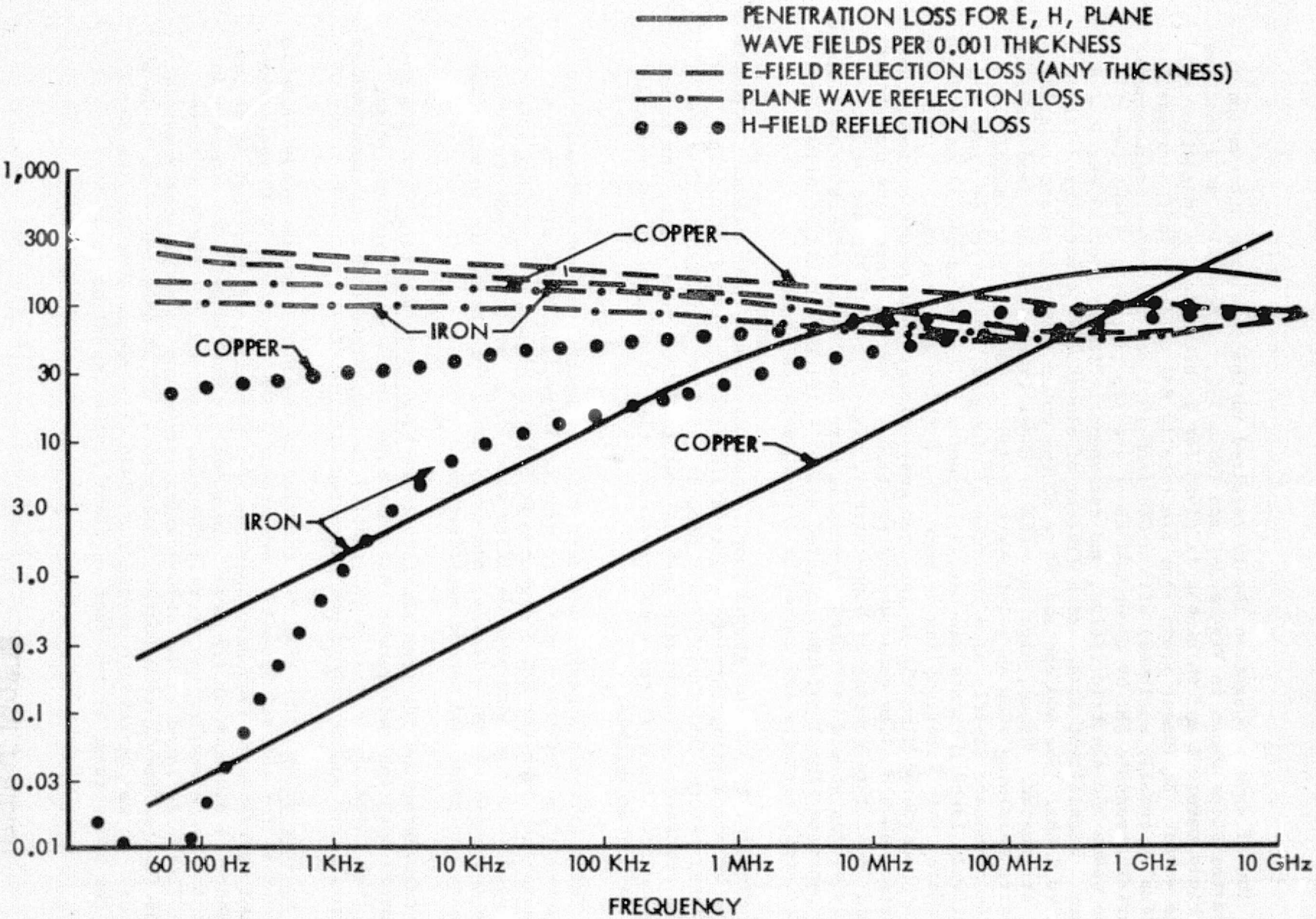
Use of wave propagation theory resulted in the shielding attenuation characteristics shown in Figure 3-5 and Table 3-2. Attenuation as a function of shield material and thickness is given for E (electric), H (magnetic) and plane waves. Equipment items that are totally EMI enclosed (not necessarily physically totally enclosed) with 0.040-inch (0.1 cm) thickness ferromagnetic material attenuate EMI by about 200 dB or greater (factor of 10^{20}) for all plane waves and electric fields, and for magnetic fields over 10 kHz in frequency. Significant attenuation (factor of almost 10^6) occurs for H-fields down to 1 kHz. The 400 cps and 50 to 60 cps power frequencies are relatively less attenuated. Hence, high currents of these frequencies may need special or extra shielding such as multilayers including copper. Since magnetic fields attenuate rapidly as a function of distance, only circuits close to relatively large currents are usually affected (i.e., 12 inches/30 cm or less). Therefore, this intercoupling is more of a problem with external cabling, which is not considered directly in the item evaluations. However, the item output interface should allow good cabling practices. That is, interface connectors should facilitate routing of high-current, high-frequency signals or power supply wiring should be routed to special wire bundles and effectively shielded. Also separate signal returns, twisted and/or shielded, should be allowed by input/output circuits and connector interfaces when needed.

Finally, to prevent ground loops (that may induce input signal components caused by circulating currents due to differences in ground potentials) the dc signal returns and chassis/case grounds should be isolated so that they can be separately (tree-branch fashion) returned to single connecting points in Spacelab. Small filter capacitors connecting chassis to signal returns were deemed acceptable.

These criteria appear consistent with the specifications reviewed, but are more design definitive so as to provide a specific means with which to evaluate each item for EMI design compatibility. Again, the complex nature of EMI suppression warrants more detailed study in order to generate more complete cook-book design criteria, and exceptions, for actual use in selecting Spacelab equipment and needed modifications.

Considerations for item sensitivity to externally generated EMI is a non-mandatory Spacelab requirement that is treated in the next section. Also, note that internal-to-an-item EMI control is considered to be the experimenter's responsibility and therefore not addressed within SEEIR.

Audible Noise. The ESRO RFP referred to the NC50 standard noise criteria (NC) curves for general Spacelab environment. ERNO stated a 55-dB requirement, without reference to frequency spectrum, for Spacelab and also that 40 dB (no reference to distance or frequency was given) is the budget for each item in order to assure meeting the overall Spacelab requirement. The NC50 curve (MIL-STD-1472A, dated 15 May 1970) varies from about 73 dB at approximately 20 cps (center frequency of octave bands) to 47 dB at 4800 cps, with 55 dB at 300 cps. It was decided to retain the 40-dB item requirement for the 20 to 4800 cps audio range at two feet in front of the installed item.



REFERENCE: ELECTRO TECHNOLOGY, NOVEMBER 1966, P. 85 - 94

Figure 3-5. Shield Effectiveness versus Frequency

Table 3-2. Calculated Shield Effectiveness Of
0.040-Inch (0.1 cm) Sheet Iron (Copper)

FREQUENCY	FIELD INTENSITY REDUCTION (DB)					
	H-FIELD		PLANE WAVE		E-FIELD	
60 Hz	12	(25)				
400 Hz	40	(30)	100	(150)	240	(300)
1 KHz	55	(34)	140	(150)	200	(240)
10 KHz	185	(45)	255	(160)	310	(200)
100 KHz	615	(90)	680	(200)	750	(240)
1 MHz	1,350	(150)	1,300	(220)	1,350	(250)
10 MHz	3,200	(470)	3,270	(480)	3,300	(550)
100 MHz	5,500	(1,250)	5,500	(1,250)	5,500	(1,300)
1 GHz	6,500	(4,000)	6,500	(4,000)	6,500	(4,000)
10 GHz	5,500	(12,000)	5,500	(12,000)	5,500	(12,000)

Some items have intermittent high-noise levels. A tape recorder rewinding a tape is a typical example. This type noise can be a beneficial warning signal and is generally of short duration. Therefore, to quiet such designs was considered unnecessary and probably not in the best interests of safe operation aboard the Spacelab. Hence, exception was made in the SEEIR for such short-term loud noises.

Again, further analysis--possibly, working models--is warranted to set more substantiated criteria. It was found that cooling fans in some equipment are relatively noisy. Cost of their modification was included in the study, but exceptions could possibly be taken in the final analysis.

Vibration-Shock-Acoustics. Vibration, shock and acoustics can also be considered a safety requirement to the extent that contribution to causing loose or shattered items in Spacelab could occur. However, this is only one possible cause of shattering. Of prime concern is the disturbance of electrical and mechanical adjustments, loosening of structure, and component failure due to fatigue or yield-limit stresses. Performance during the high vibration periods is assumed to be unnecessary since equipment will be "OFF" in general.

ERNO documentation states that shock will not be a driver. Since sources of shock are isolated through various attachments and structure, the energy will probably be converted to a vibration input at most item mounts, supporting this conclusion.

The ERNO acoustics-level information was included in SEEIR for completeness. The acoustics input from Shuttle is presumed to be transformed into the ERNO-specified acoustics and vibration as a result of structure and attachment characteristics. However, the acoustics impact on experiment equipment in general is considered insignificant compared to direct vibration inputs at mounts. Each item is, however, evaluated for any unusual susceptibility to acoustic inputs.

Of particular concern for item vibration acceptability are loosening of screws (chassis, parts, knobs, thumbscrews, etc.), circuit card deflection (oil-canning), parts and wiring fatigue breakage, and yield of solder joints or leads for "heavy" lead-mounted parts, secondary resonance drivers (transformers on "flat plates"), cathode ray tube (CRT) neck supports, cantilevered mounted parts, electronic and mechanical adjustments (decalibration), connector demating (harness, circuit cards, input/output) and other parts subject to resonance, yield or fatigue stress breakage. Each item was evaluated for such factors. However, there is great uncertainty as to the specific ability of an item to withstand vibration. The evaluation judgments made are felt to be representative for group costing purposes, but evaluation tests and/or refined evaluation rules are needed to better identify all problem modes on specific equipment.

Atmospherics. Specifications for relative humidity, particulate contamination, and the nominal equivalent air atmosphere were defined in the specification. These criteria were derived from the ESRO RFP and/or an interim NASA Sortie Lab reference document for experimenters. It was assumed that the experiment equipment would not be required to be functional after a Spacelab depressurization since depressurization is not a Spacelab design requirement and would undoubtedly result in an aborted mission in any event. The safety aspects of depressurization, however, must be considered regarding the release of fluids/gases or shatterables.

3.2.2.4.3 Item Performance

Mounting Locations. The ESRO RFP, ERNO and MBB designs indicate that 19-inch standard rack-mounted equipment items are desirable. Cooling, volumetric efficiency, integration, human factors, safety and other factors can presumable be more efficiently handled in this way. Racks can be made available for ceiling and under-floor as well as wall mounting. Therefore, the SEEIR provides for evaluating each item for suitability for rack-mounting. The requirement implies evaluating first for volumetric suitability. Where existing item design is for 19-inch racks (with or without catalog accessories), the capability for Spacelab installation (human factors, vibration and crash loads with respect to mass) is still necessary. NIM, CAMAC and other smaller size modules can fit into 19-inch rack-sized bins, crates or other substructures. Items not suitable for rack-mounting are assumed to be bench/shelf-mounted. The rack is assumed to have vibration/shock isolators with the resulting vibration characteristics cited in SEEIR. Benches were assumed hard-mounted so that any shock-mounting must be incorporated into the item or its mounting. In the absence of rack design criteria, it was assumed that cooling air would be made available in parallel to each item with needed ducts, deflectors or directors. Also, a rack-mount guide rail and support pin configuration was adopted for relatively heavy items.

EMI Susceptibility. It was necessary to convert EMI system requirements, such as a 6-dB margin between susceptibility and background EMI levels, or test levels/condition in MIL-STD-461 and -462, to design criteria that could be evaluated on each item. Internal generation-interference modes are assumed to be the responsibility of the experimenter. The requirement of the 0.040-inch (0.1 cm) metal case for generated EMI attenuation also provides incoming attenuation (shown by Figure 3-5 and Table 3-2), the same as for the EMI generation case discussed previously (3.2.2.5.2).

Isolation of input/output (I/O) circuit signal returns and common and power grounds avoids "reception" of common mode noise as well as the prevention of "transmission" discussed above. In addition, voltage levels and I/O circuit impedance requirements are specified in order to reduce the sensitivity to noise signals from high impedance coupled sources. Five to 12 volts output signal voltages were chosen since they are popular levels successfully used in industrial and avionics noise environments when proper design and installation rules are observed. The 10-K ohm minimum output impedance is easily obtained with transistorized circuits. A lower value could prove more desirable and would not appreciably affect the cost analysis for the study. The same voltages and impedance were assumed for full-scale analog signals. Theoretically, analog signals could run near zero volts although generally the signals of interest are made to run nominally at 2/3 to 3/4 full scale.

Input commands and other signals of an item must be compatible with the output voltage and impedance criteria of interface units. It was assumed that command logic would be in the 5- to 12-volt range with a 1-K ohm impedance. This would be a Spacelab design requirement.

The Spacelab remote acquisition units (RAU's) should provide for adjustable scaling within the noted voltage and impedance ranges, as a minimum, in order to avoid the general need to add circuitry to off-the-shelf items.

The voltage-impedance-connector requirements were not applied to front panel input/outputs intended for test probes or reconfigurable patch wiring to adjacent modules when evaluating items for suitability.

Input Power Form. The power forms established are consistent with the ESRO RFP. Regulation tolerances associated with each voltage level were selected from other documents and typical practice. It is assumed that the quantity of each Spacelab power type can be adjusted with parallel building-block converter units as long as the total available power, including conversion inefficiency, does not exceed the total allotted to experiment equipment.

A key assumption is that all ac power forms can be held to ±1.0 cps in frequency. This appears reasonable, assuming electronic converters, and desirable since commercial equipment sometimes uses line frequency for clock/gate/trigger timing. Finally, the 50-Hz source was added since the ERNO RFP indicated the requirement. However, simplification in power converters appears possible by using only a 60-cycle source since 50-cycle equipment generally operates satisfactorily on 60 cycles. More effort is also justified to further refine Spacelab power supply requirements such as transient regulation, short-term frequency stability, etc.

The SEEIR document states that equipment items using 1.0 kw or more shall consider more efficient use of power. In retrospect, since this represents one fourth to one third of the available power, and since most experiments appear well below this need, 250 watts appear to be a better upper limit to require special efforts and integration coordination. Each mission will require a Spacelab management effort to coordinate total power usage timelines in order to assure adequacy of support without overloads.

More efficient means of power conditioning and distribution might be effectively implemented in the Spacelab; i.e., each rack could contain all power converters needed for that rack. The possibility of requiring the experiment packages to use +28 vdc only was considered. However, a trade study (see 4.3.4) showed such an approach to be undesirable. Most packages convert ac to many secondary voltages, few of which are near +28 vdc.

Data Handling. Data handling is assumed to be a Spacelab core function and, similar to power, not budgetable to individual items in a general SEEIR document. The capability stated in SEEIR generally reflects interpretations from ERNO documents as well as ESRO RFP requirements. This has little impact upon equipment items except to identify the need for interface capability. RAU capability to scale 5- to 12-volt logic or full-scale analog was assumed, consistent with the EMI requirements as discussed above. Where outputs to cabling do not meet requirements, buffer amplifiers were added.

Thermal. Values for ambient, wall, touch and ground storage temperatures were basically taken from ERNO documentation and/or the ESRO RFP. These temperatures, along with relative humidity, are key values in evaluating requirements. However, since they are relatively benign, small changes would have little impact on equipment modifications.

It was assumed in SEEIR that coldplates and rack air cooling would be provided by Spacelab. Although two units were water-cooled, the furnace and the laser, none of the units analyzed required coldplate cooling. Instead, the designs provided for internal water cooling. It is not clear at this time whether a liquid coolant interface to experiment equipment will be available in the Spacelab. Further studies of equipment planned for the Spacelab should be made to resolve this issue.

It was assumed that units with fans did not need additional cooling provisions unless obvious dead-air spaces containing significant power dissipation were present.

Zero-G Compatibility. The main areas of concern, as a consequence of placing 1-g designs into a zero-g environment, are functional capability and power dissipation. Human factors is a potential area for concern, however, it appears that usual operations on equipment such as adjustments, controls and switches can be operated effectively in space as long as shirtsleeve conditions and positioning restraints (foot/hand grasps, etc.) are adequate. Loose accessories, however, must be constrained from floating away in zero g.

The functional operation of each item requires careful scrutiny for subtle as well as obvious effects of gravity operations. A general test is to ascertain that operation is independent of orientation in a 1-g environment, which is not currently stated in SEEIR, but was used as a tool in evaluating each item.

The absence of natural convection in a zero-g environment requires evaluation of each unit for adequate thermal dissipation. For instance, the need for convective air currents in enclosed boxes is not obvious without access to design data. Therefore, it was assumed that moving air would be required over any power dissipation point unless it could be shown that direct conduction paths were adequate to dissipate the thermal energy to the external surface of the unit. External air circulation was assumed to be adequate in all cases.

3.2.3 Results of Analysis

A summary of results of the suitability analysis is presented in this section. The first portion includes illustrative examples of suitable and unsuitable conditions observed on the 34 items evaluated. A summary of the unsuitable conditions for all 34 items is presented in the last part of this section.

The type of modifications recommended for each item is presented in Section 3.3. Volume III provides the detailed evaluation of each item.

3.2.3.1 Examples of Suitable and Unsuitable Equipment Features

The following sequence of photographs were taken in conjunction with the suitability evaluation. Several dozen photos were taken of all but 6 of the 34 items. Those shown illustrate the range of suitability problems encountered.

Collins Transceiver. The Collins VHF transceiver, illustrated in Figure 3-6, is used in two-way communications and is potentially usable for the COM-NAV missions. It is illustrative of an ATR (Austin Trumbull Radio--commonly known as Air Transport [Association] Requirement) modular design with extensive, reliable commercial and private aircraft service. The design criteria are defined by ARINC (Air Radio, Inc.) for these units. It is an example of hardware that requires little if any design modifications for Spacelab experiment use. The close-to-the-board IC mountings and circuit board fastening indicate good resistance to vibration effects. Its totally enclosed case design eliminates any flammability problem since fire cannot propagate from this box, and the stagnant air inside the box would cause any flareup to be self-extinguished. The unit is qualified to operate up to 55,000 feet, which is an equivalent cabin pressure of approximately 1.5 psia. As a result, thermal dissipation by conduction to the outer case and mountings is designed into the unit. Even though the unit is enclosed, a 150-hour bakeout to drive off residual surface contaminants was recommended for costing purposes.

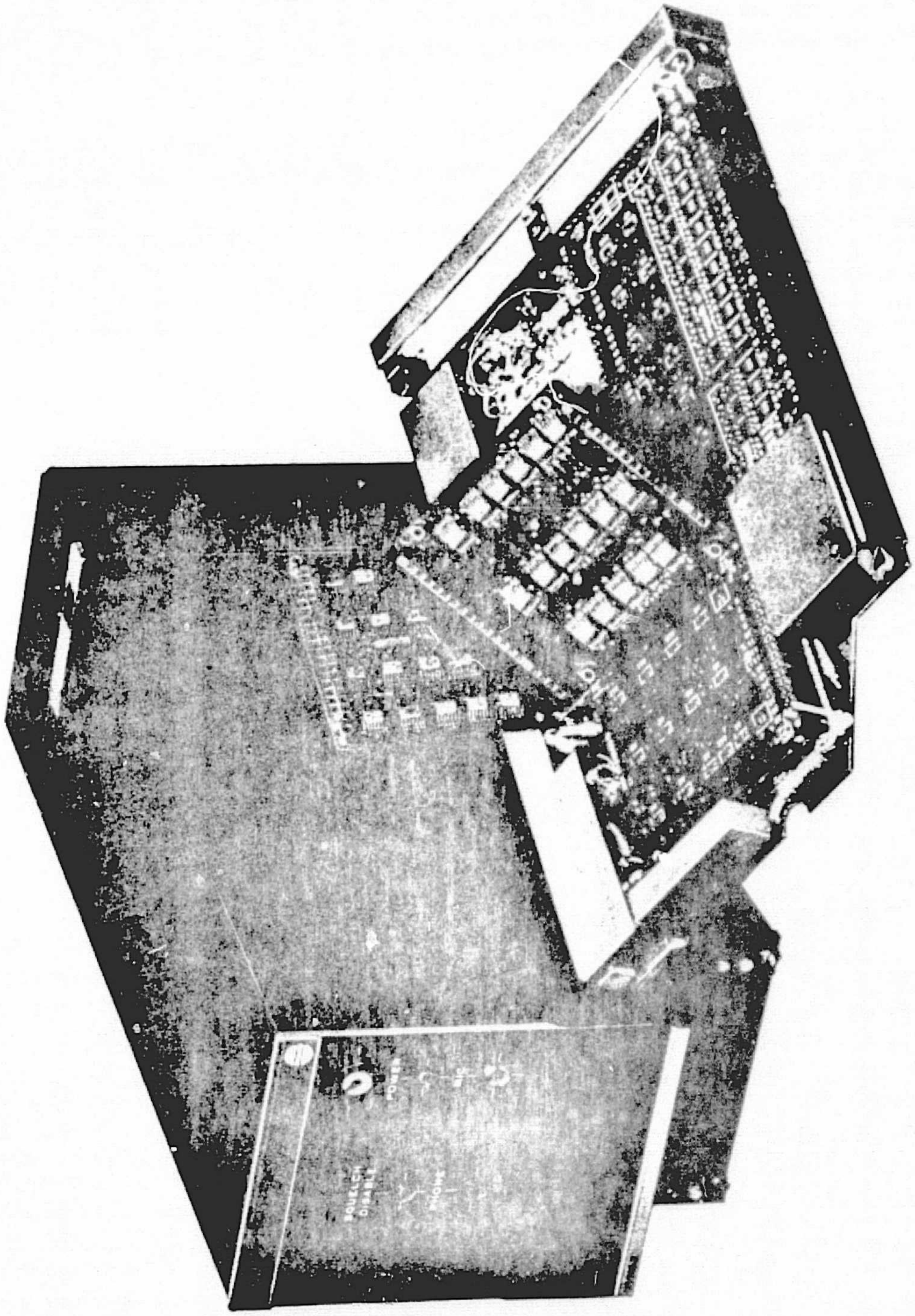


Figure 3-6. Collins Transceiver

Views of the transceiver chassis, shown in Figure 3-7, illustrate mounting of heavier electronic components and internal EMI shielding. The heavy transformer is center-mounted rather than end-mounted. Electronic components are lead-mounted in such a way as to minimize the possibility of fatigue bending due to vibrations, and have relatively large lead cross-sections to support the component masses. This item could be a candidate for procurement later to confirm its apparent vibration integrity.

Hewlett-Packard Spectrum Analyzer. The H/P spectrum analysis equipment, pictured in Figures 3-8 through 3-12, illustrates typical high-frequency analyzer equipment studied. This system analyzes radio frequency inputs for various bandwidth energies and waveform characteristics, and is potentially usable in atmospheric physics, earth observations, life sciences, and space technology payloads.

The system illustrated consists of a mainframe display unit. Plug-in modules are RF and IF spectrum analyzer modules. These units are combined in a single package with built-in forced-air cooling. The automatic preselector on top of the mainframe unit is structurally independent with its own forced-air cooling fan.

Modifications recommended for this unit are not extensive. Control panel knobs were replaced because they are plastic. A different non-shatterable faceplate over the CRT display face is necessary to protect the astronaut from fragments resulting from implosion. The panel handles require modification or guards since the edge radii are less than 0.5 inch (1.25 cm). The panel knobs require shielding from bodily contact. The design guidelines discussed in Section 3.3.1 were developed to solve this typical guardrail requirement. The front panel signals going through the BNC-type coaxial cable input/output connectors are not required to meet the impedance and voltage level requirements of the EMI criteria of the SEEIR because these inputs cannot be modified without affecting performance.

Figure 3-9 displays CRT installation typical of electronic instrumentation. Modifications identified include closing all openings in the CRT shield with suitable mesh screening in order to trap glass particles should CRT breakage occur. The filter on the fan inlet would probably be adequate to prevent flaming particles from passing through. The outlets are in the form of open holes approximately 3/16-inch (0.5 cm) in size, which are typically assumed to need screens to contain shatterables and/or potential flaming particles. High heat dissipation power transistors are mounted close to the fan outlet, eliminating any cooling shortcoming in zero g. The large electrolytic capacitor bank needs support due to cantilevered mounting

The module shown in Figure 3-10 illustrates ruggedness and EMI shielding typical of many well-designed commercial high-frequency instruments. Well-anchored cabling indicates good vibration integrity although the wiring bundles must be replaced because the wires are insulated with PVC. Polyvinyl chloride is not an acceptable material from flammability and outgassing standpoints. The large number of electrical calibration adjustments need staking for protection against vibration.

Figure 3-7. Collins Transceiver - Chassis View

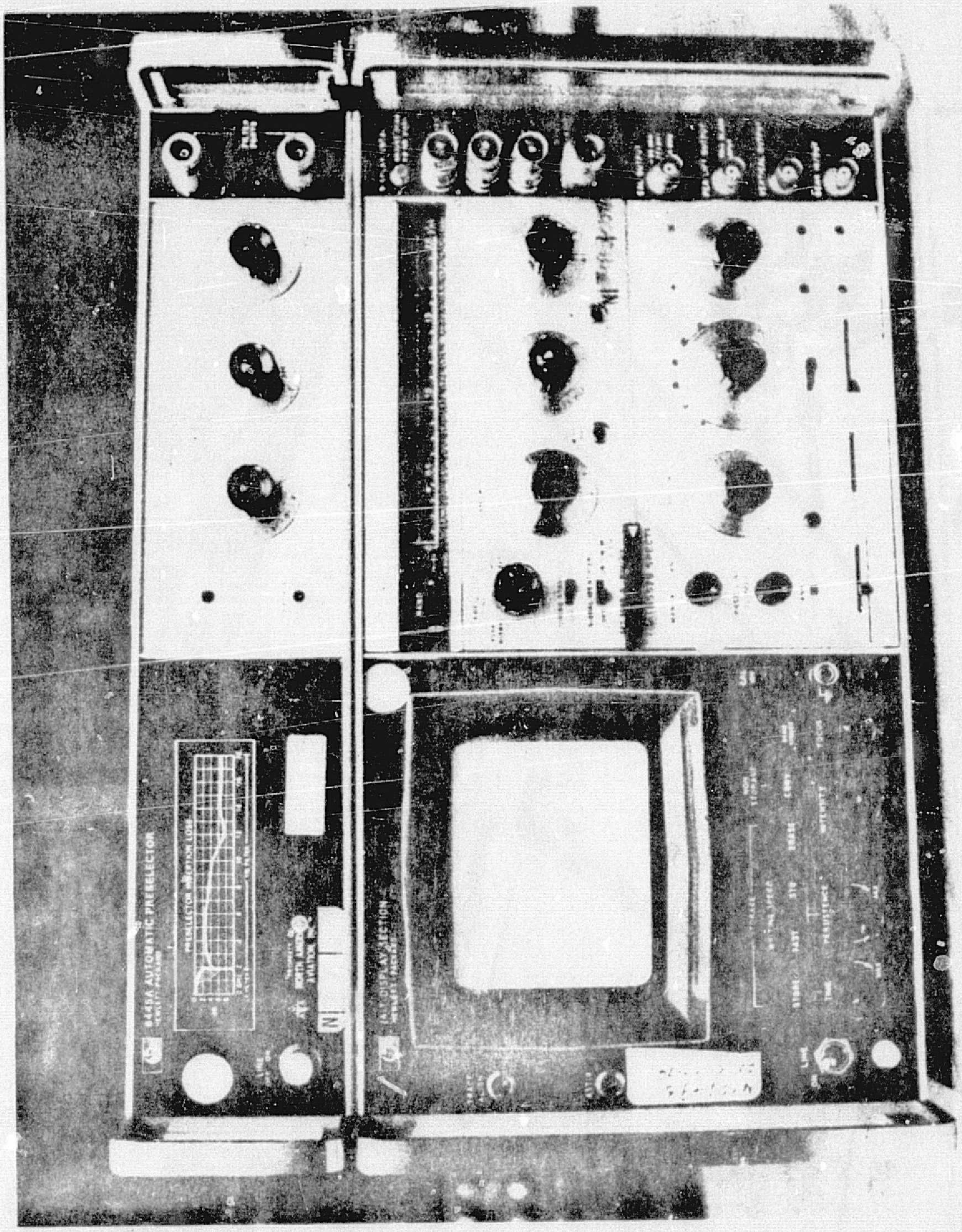


Figure 3-8. Hewlett-Packard Spectrum Analyzer

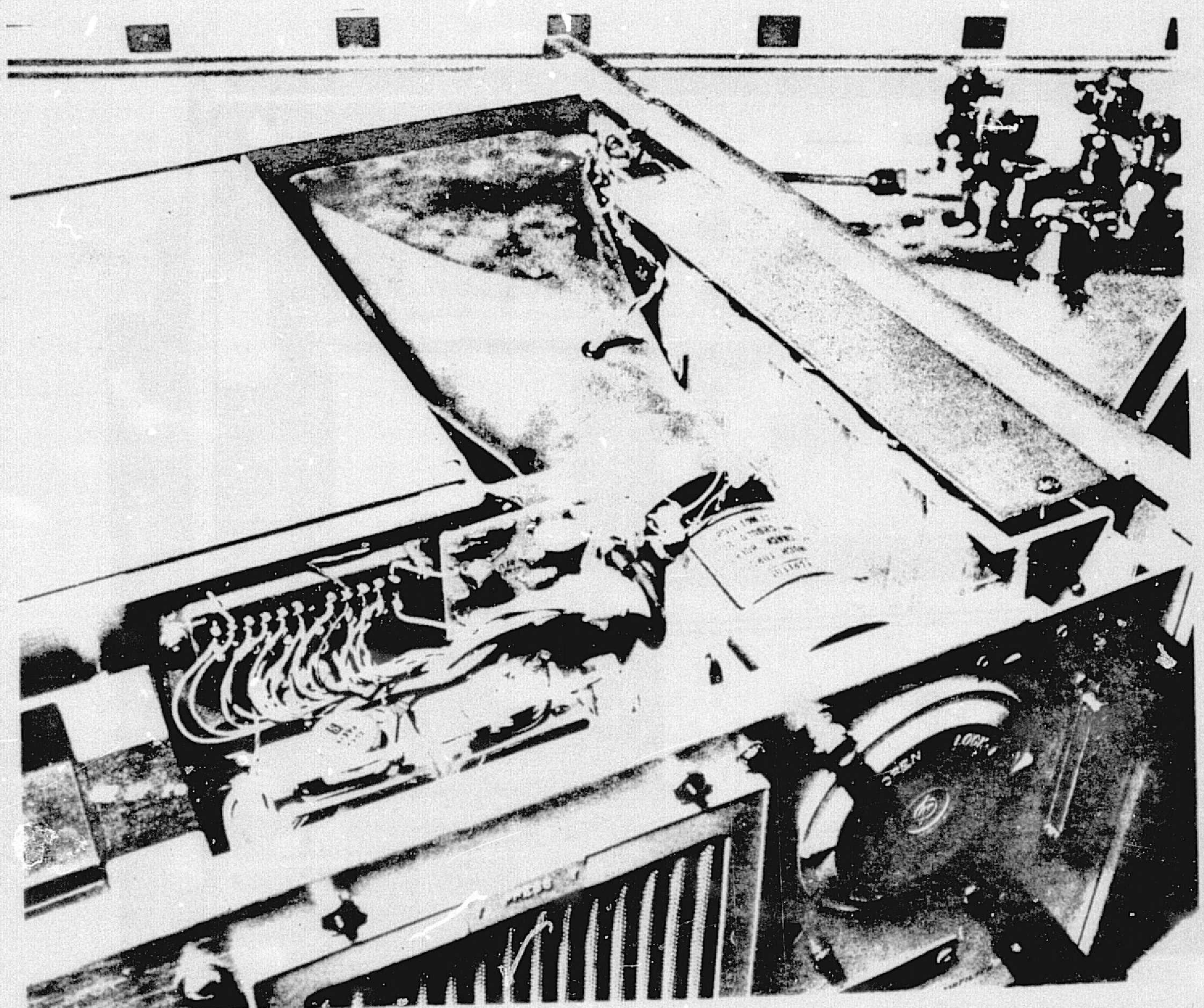


Figure 3-9. Interior View of H/P Spectrum Analyzer Display Section

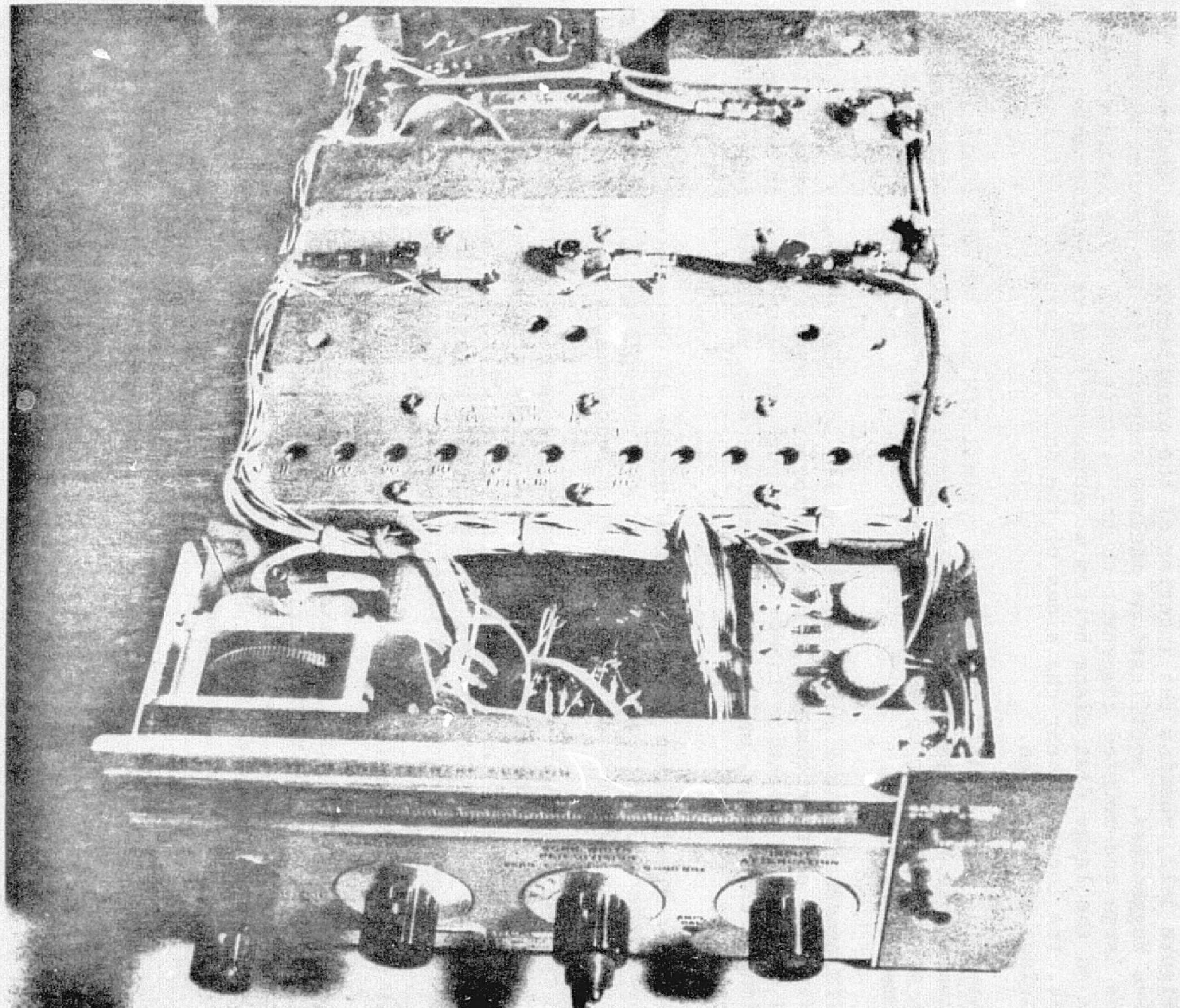


Figure 3-10. H/P Spectrum Analyzer - RF Section

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Figure 3-11, the photograph of the IF unit, illustrates typical circuit board construction. The boards with relatively heavy parts in particular may need added support/dampening to prevent "buzz" and "oil-canning." Conformal coating to better anchor the relatively high-mounted, thin-leaded ceramic capacitors and reduce fire and trace contaminant hazards is recommended.

Figure 3-12, showing the interior of the preselector unit, indicates relative ruggedness. Modifications include support for the tubular waveguides and the large end-mounted component on the circuit board. The large transformer on the large flat plate bottom mounting surface is questionable. However, its location near the sides of the unit was assumed sufficiently stiff to preclude modification.

NIM Bin. Figure 3-13 illustrates typical NIM modules and their 19-inch rack-compatible bin which contains these modules. The modules shown include signal conditioners set up as a single-channel wave analyzer for nuclear instrumentation inputs.

NIM components have potential use on all Spacelab missions. They offer the advantage of interchangeable modules for easy maintenance, relatively rugged design for vibration integrity (although circuit boards do require additional stiffening), and venting provisions compatible with forced-air cooling.

A major disadvantage of this type of design is the poor volumetric and weight efficiency, which is a penalty for the convenience of a modular design approach that allows a wide range of custom functions to be mechanized.

A typical NIM power supply attached to the rear of the NIM bin is shown in Figure 3-14. The resultant cantilevered weight will require either special end support for the bin, or moving the power supply to an independent rack mount location. Depending on the voltage levels of available power in the Spacelab, the power supply could be eliminated. NIM modules are compatible with 12-volt and 24-volt dc power. Also, off-the-shelf power supplies of various types that mount in the bin are available.

Tennelec NIM. Figure 3-15 shows typical NIM design practices. TFE wiring is often used. Circuit boards tend to be rather large and may need stiffeners to prevent excessive deflections (oil-canning). Fiberglass circuit boards are also often used for excellent fire resistance. Conformal coating is recommended to support lead-mounted ceramic capacitors.

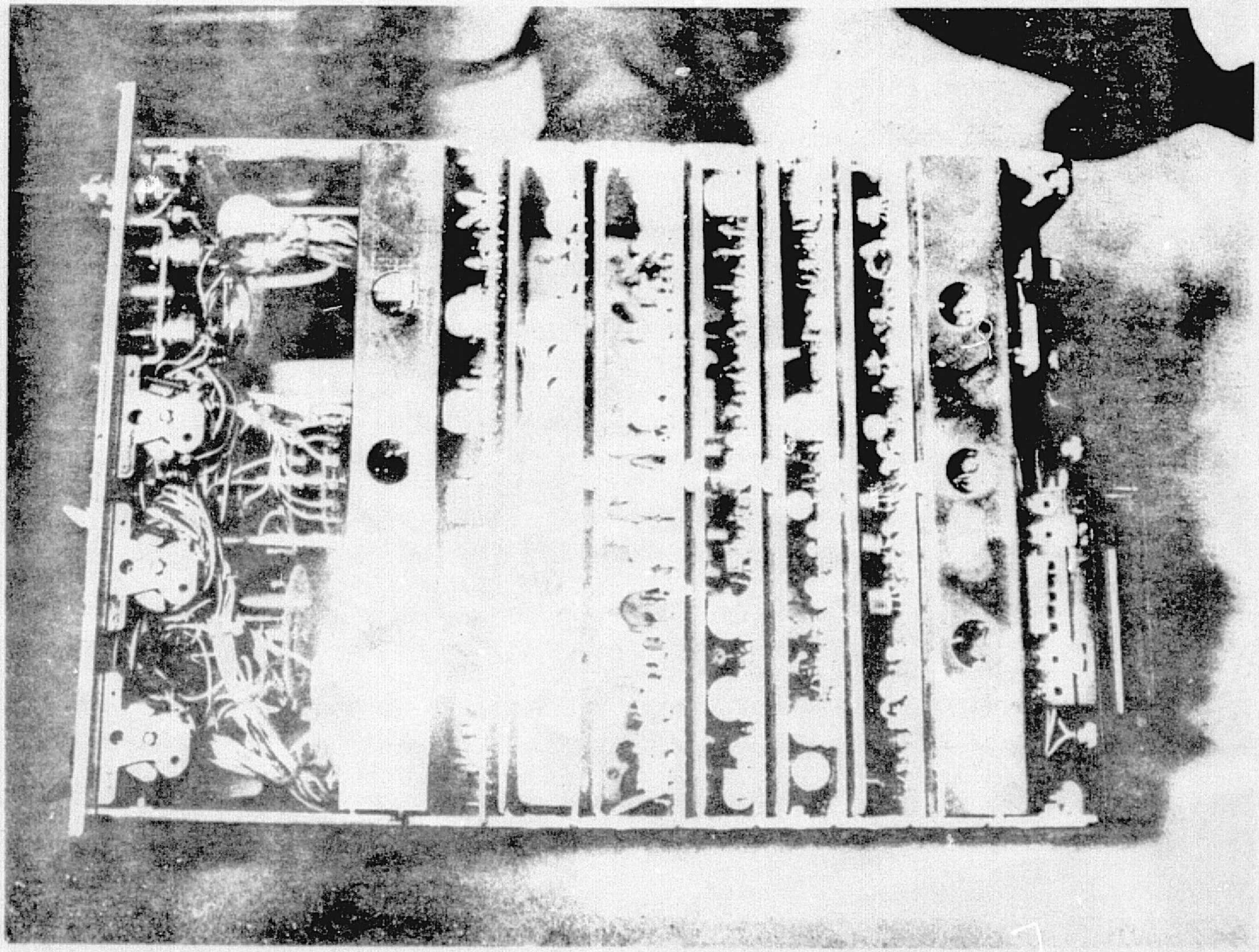

Figure 3-11. Interior View of H/P Spectrum Analyzer IF Section

Space Division
Rockwell International

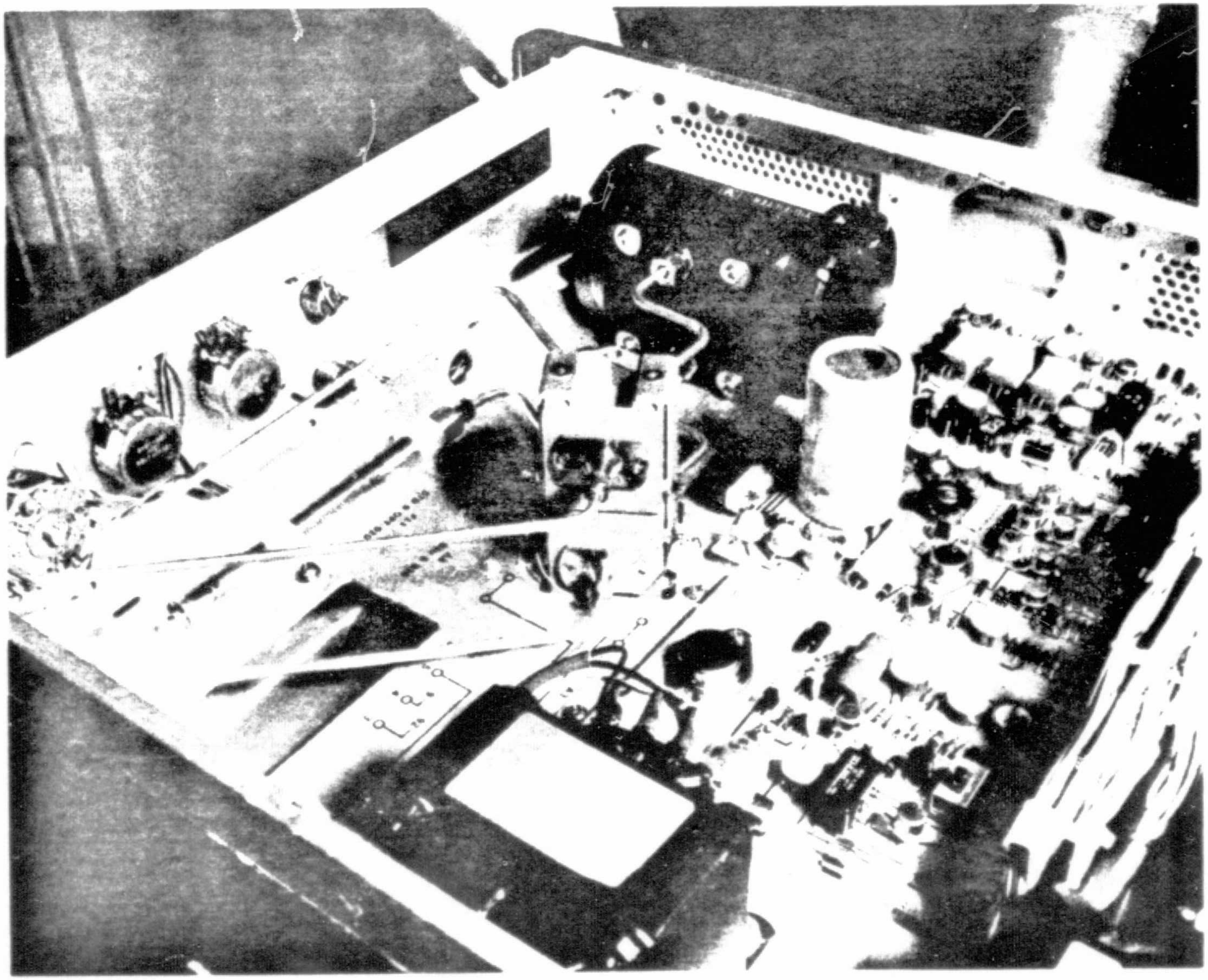

Figure 3-12. Interior View of H/P Spectrum Analyzer Automatic Preselector

Space Division
Rockwell International

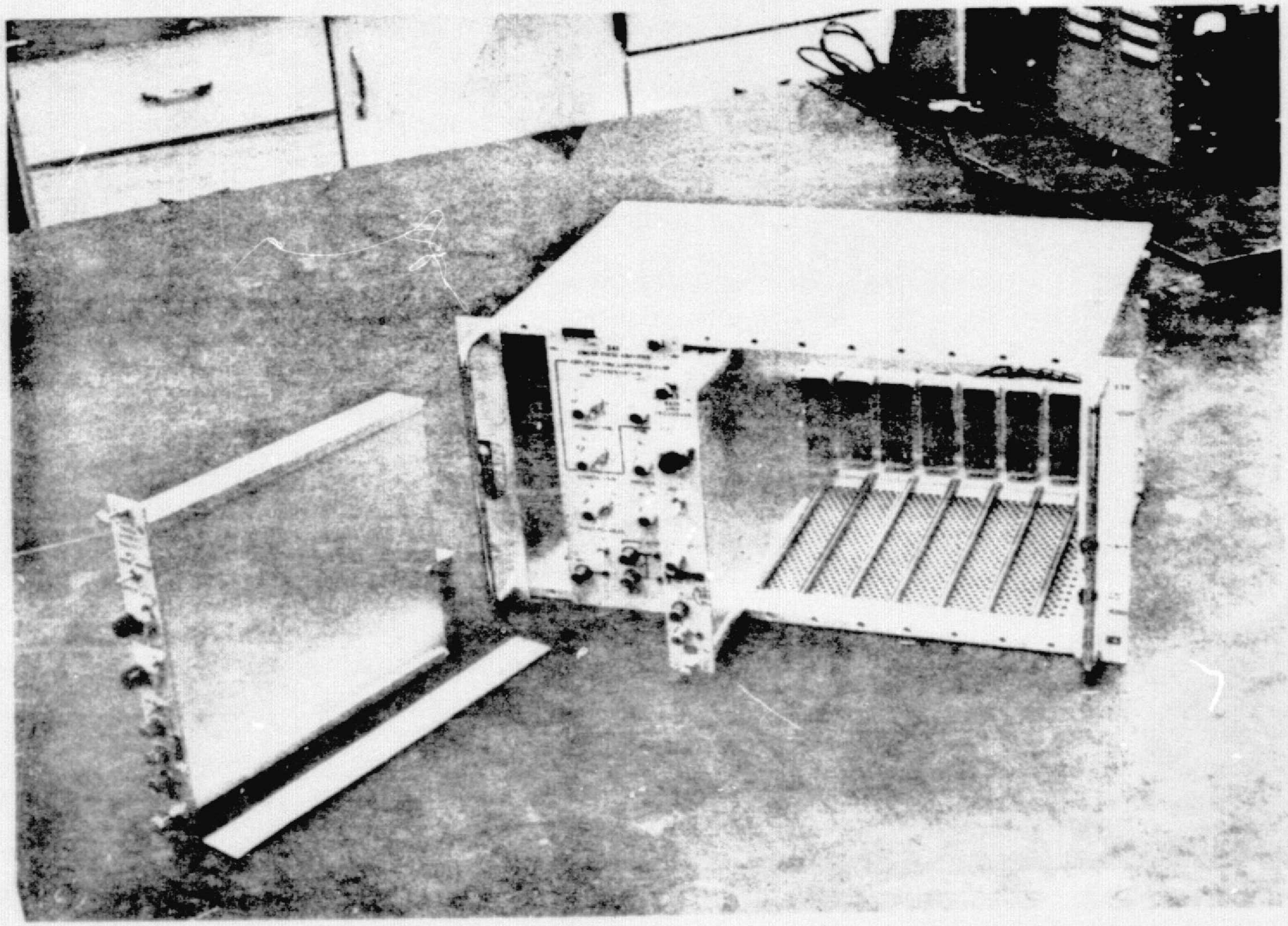

Figure 3-13. NIM Bin With Modules - Frontal View

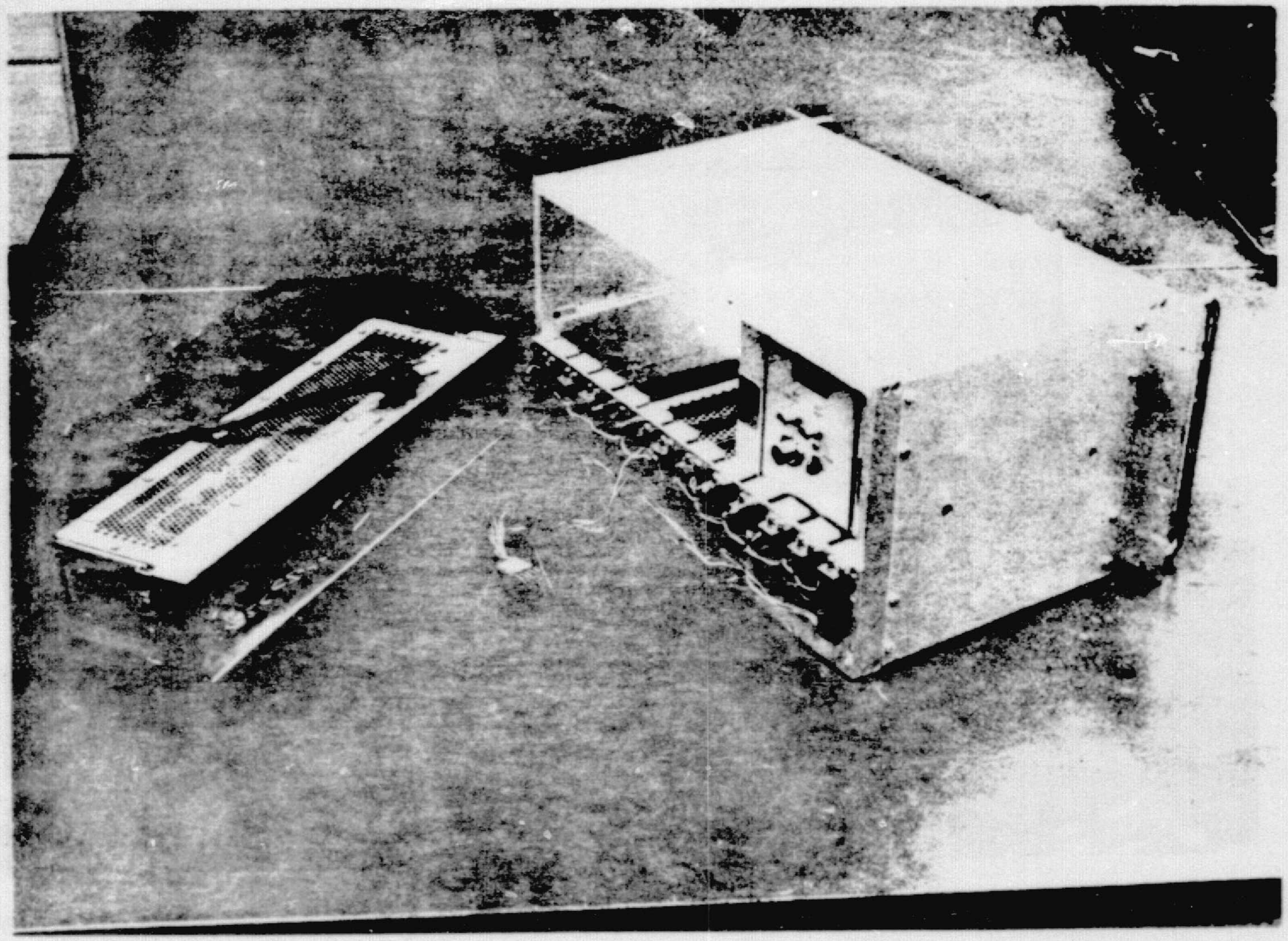

Figure 3-14. NIM Bin - Rear View Showing Power Supply

Space Division
Rockwell International

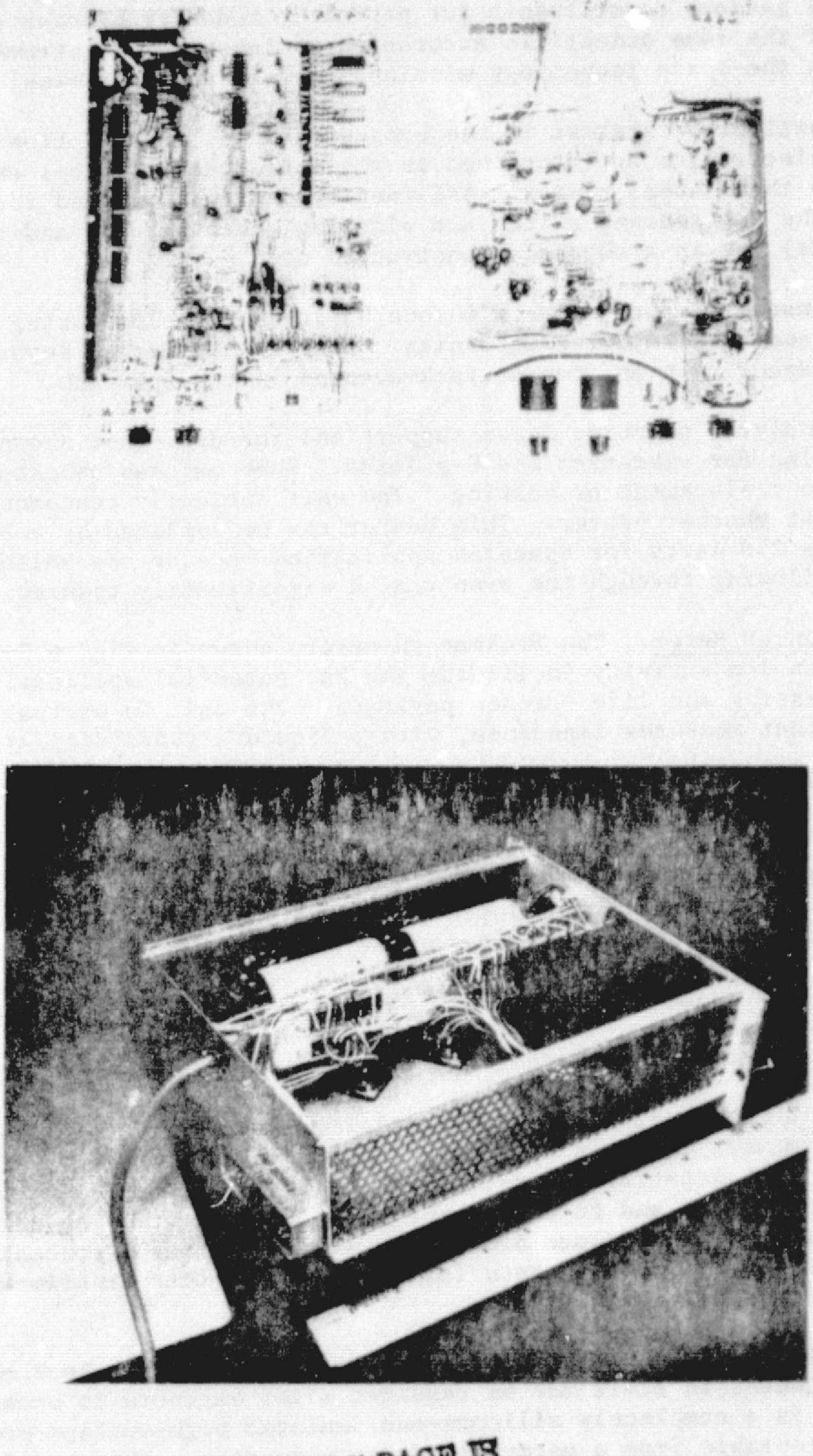

Figure 3-15. Tennelec NIMS - EMI Covers Removed

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Beckman Gas Chromatograph. The gas chromatograph, shown in Figure 3-16, identifies gaseous constituents for petroleum industry process control. It is capable of the same scientific accuracies as laboratory instruments, and can be used on the space technology missions as well as other missions.

Of particular interest is the explosion-proof construction of this unit. Integral electronics are contained in the three heavy (white) cans, which are mounted to thick steel plates. TFE-insulated wiring is used for low flammability. The gas routing switch and plumbing, heating unit and the sensor (right side) are in a ruggedly constructed oven.

The insert picture shows a unique built-in troubleshooting panel located in the process controller electronics. This controller is separately located from the sensor unit and can be rack-mounted in the Spacelab.

The analyzer plumbing needs support and the door (not shown) needs positive latching for vibration and 9-g loads. Some exposed asbestos fiber insulation needs replacement or coating. The unit currently consumes 1500 watts for the test chamber heater. This heater can be replaced by a component dissipating 250 watts for Spacelab application because the volume of air currently flowing through the oven can be significantly reduced.

Beckman pH Meter. The Beckman pH meter, shown in Figure 3-17, measures the hydrogen ion activity in liquids and has potential application to the space processing and life science payloads. The unit is basically a high-gain amplifier that measures impedance, with a liquid crystal display unit.

The following changes are proposed. The plastic case, typical of some commercial units, is not an acceptable material. The case should be replaced with metal. No cooling provisions other than natural convection are provided by this design. However, the total power requirement for the unit is only 3 watts. Since there are no single high-dissipation components and the total dissipation is low, modifications for thermal control were considered unnecessary. The glass liquid crystal display unit requires a lexan plastic shield to protect the astronauts from glass particles in case of breakage. A rack-mounted installation is recommended. The pH sensors (not shown) currently consist of open-probed containers and must be redesigned for zero-g operation.

Sylvania CO_2 Laser Interior. The laser unit, shown in Figure 3-18 with the cover removed, consists of glass tubes up to about one yard long which contain CO_2 with integral water-cooling jackets and adjustable optics to obtain lasing action and to direct the light energy out. The unit has potential application to the space processing missions where a concentrated energy source is needed for heating material samples and other experiments needing a monochromatic light source.

The unit will require special mounting with integral shock mount provisions. Alignment in orbit may be required after exposure to boost vibration. Of interest is a completely silicone-encapsulated high-voltage power module, which is acceptable from a materials usage viewpoint. The use of external water cooling requires adequate plumbing support, particular at laser connections. Also, the availability of a liquid-coolant interface with the Spacelab thermal control subsystem must be verified.

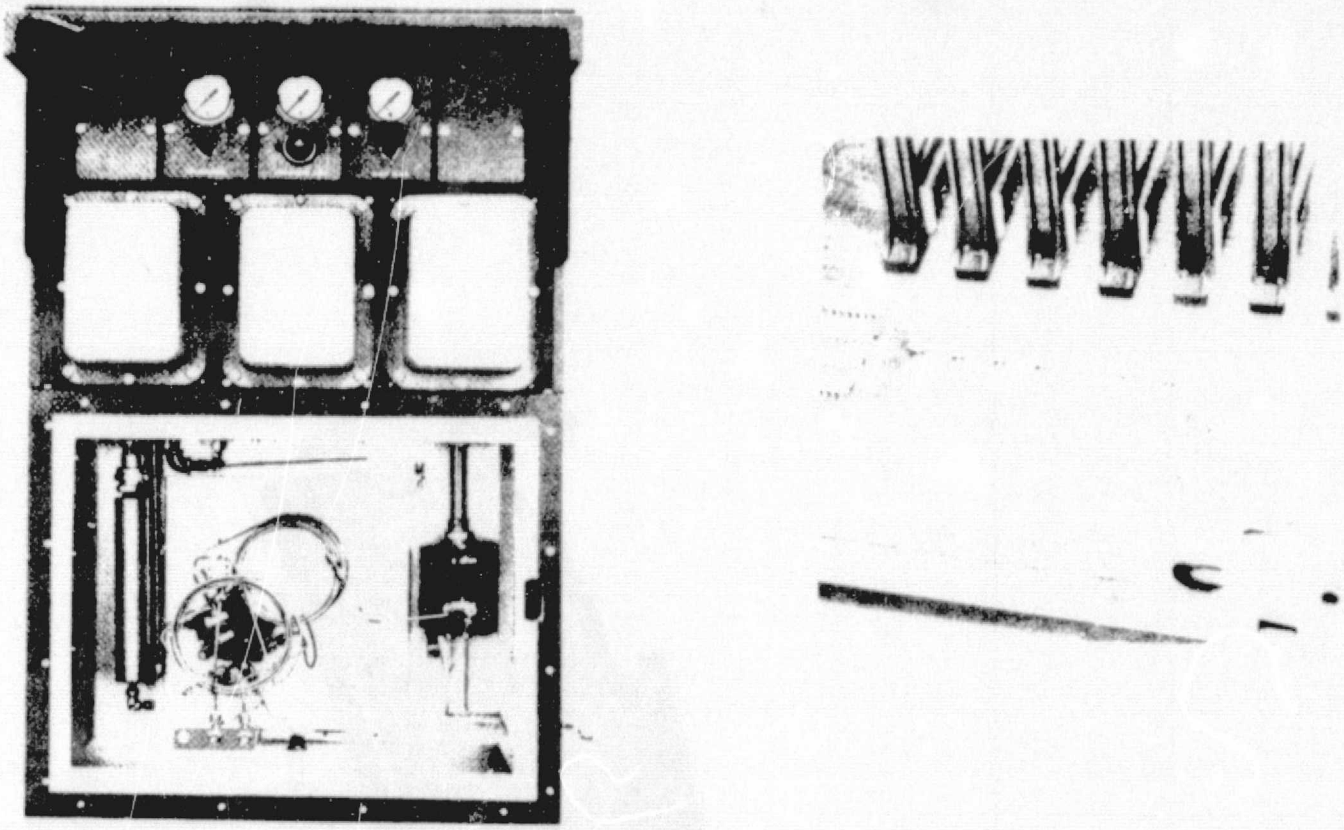

Figure 3-16. Beckman Gas Chromatograph

Figure 3-17. Beckman pH Meter

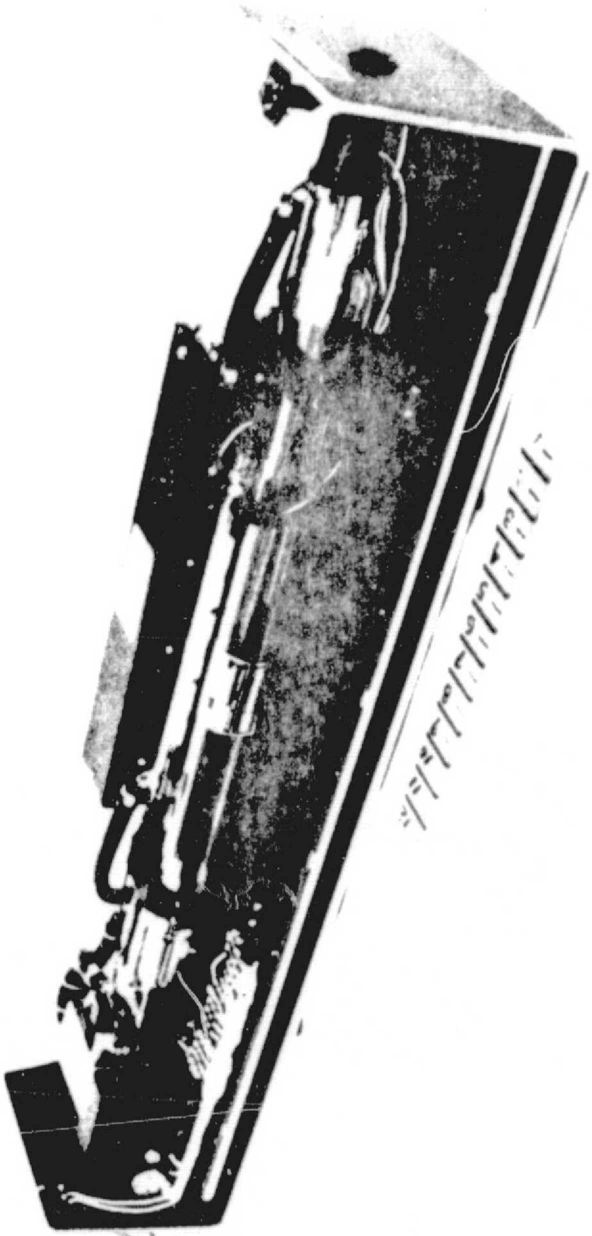

Figure 3-18. Sylvania CO_2 Laser Interior

Research, Inc. Display Terminal. The display unit, shown in Figure 3-19 without enclosure cover and plastic CRT shield, provides entry and display of data associated with computer storage and has potential use on all Spacelab missions. Although an advanced functional design, it is judged to represent an extreme of the modification spectrum for the selected electronic equipment. In this view, it can be seen that the large vertical circuit boards and the long keyboard circuit board require support to survive the vibration environment. Socket-mounted IC's and some other components may also require cementing. Ribbon cabling must be replaced because of flammable insulation. Wire runs need tie-downs. The large transformer is end-mounted on the chassis and likely to generate secondary vibration inputs. The CRT plastic face shield (not shown) needs to be better mounted and secured.

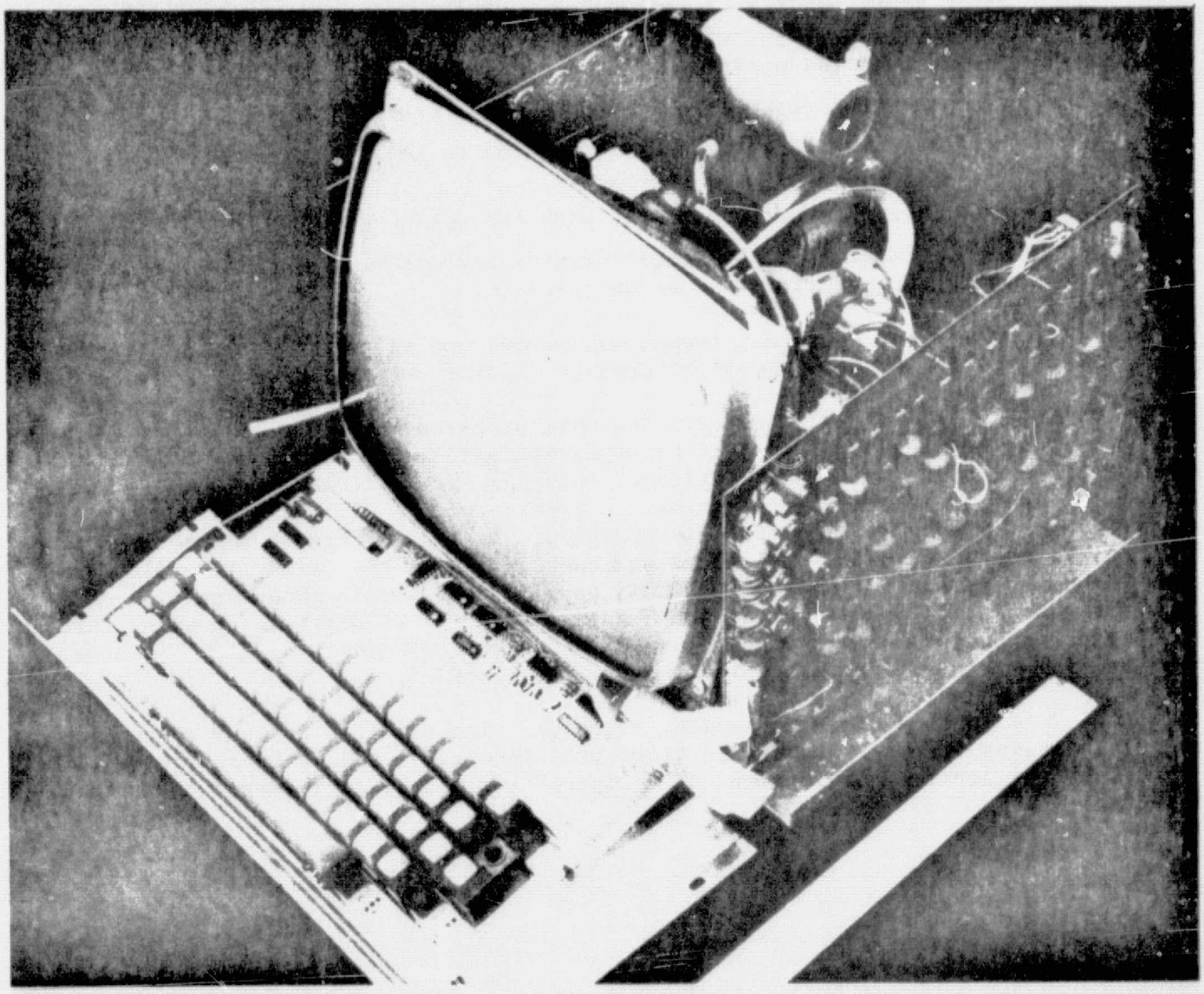

Figure 3-19. Research, Inc. Display Terminal

Additional nonsuitable design features are shown in Figure 3-20, and require the following additional modifications:

- Support large electrolytic capacitors on right circuit board. One capacitor is attached to two surfaces not rigidly attached to each other.
- Support bottom sweep generator circuit board and its components, particularly the horizontal oscillator coil.
- Isolate the powdered iron core flyback transformer from vibration to prevent fracturing.
- Provide EMI shielding for sweep and high-voltage generator circuits since these type circuits are especially good EMI generators.
- Provide support for CRT neck deflection coils and focus components; cement adjusted positions.
- Provide CRT enclosure that would contain broken glass.
- Provide porting for forced-air cooling to heat-sinked transistors, transformers, and circuit boards.
- Provide connectors compatible with EMI design control practices.
- Remove flaking high-voltage corona spray material at the high-voltage connection to tube and replace.

As with most other equipment items, all screws and adjustments not having a vibration-proof feature should be cemented against vibration.

Coulter Blood Cell Counter. The unit pictured in Figure 3-21 counts small particles, typically blood cell or other biological components, in a liquid suspension solution. The function of this unit is applicable to the life science and space technology payloads. A precise volume of liquid which is sucked through a micron-sized orifice is measured. A falling mercury manometer column, prepositioned with an integral vacuum pump, provides the calibrated volume and secondary vacuum to intake the liquid sample. Electronic impedance-type sensors and associated circuits count and display the count of particles passing through the orifice for the measured volume. Optics and CRT displays allow direct visual monitoring of particle size and orifice clogging.

This unit requires a complete redesign. Its function is gravity-dependent. It contains mercury, has little structural integrity, and is full of glass. It is the least suitable piece of equipment for spaceflight that was examined.

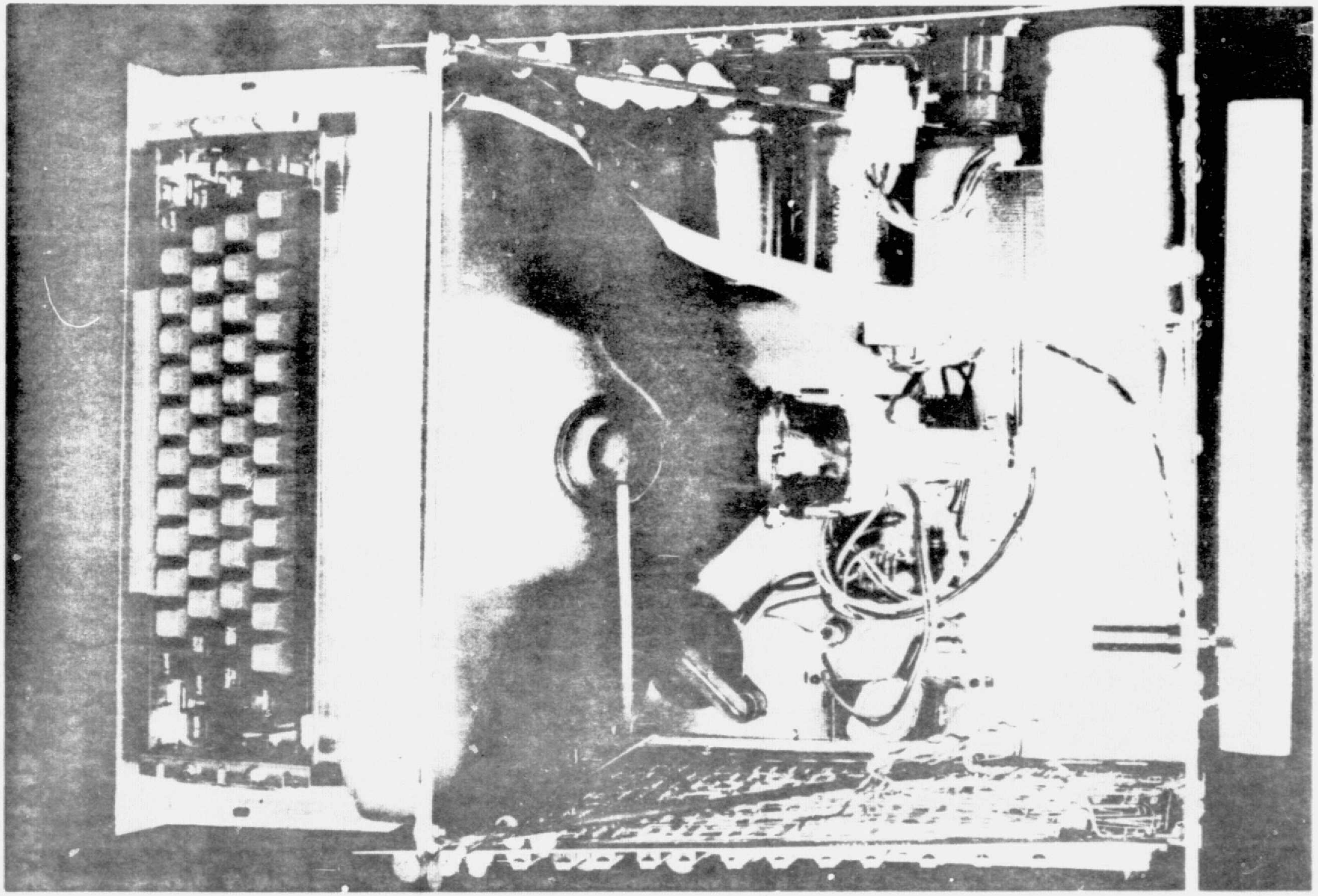

Figure 3-20. Research Inc. Display Terminal - Interior View

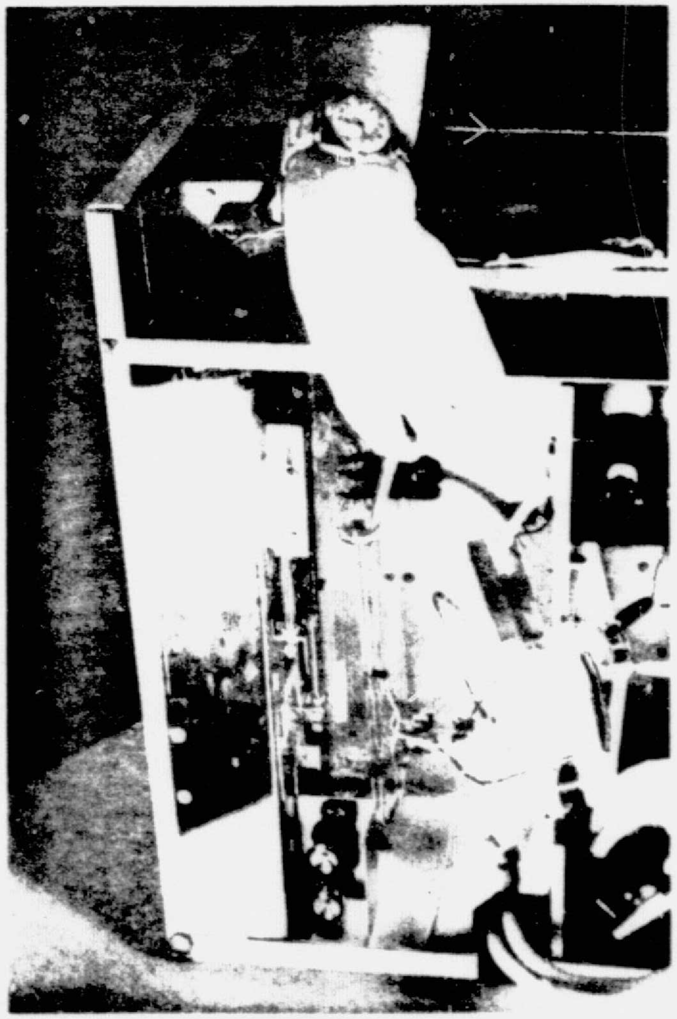

Figure 3-21. Coulter Blood Cell Counter

3.2.3.2 Modification Action Summary

The summarized results of the evaluation of 34 units are presented in Table 3-3. The table shows the number of items found to have unsuitable characteristics requiring modification. It should be emphasized that a conservative approach was taken in defining modifications in order to not undervalue modification costs nor over-simplify the degree of modification. Most modifications appear straightforward and have minor impact on a given package. Section 3.3 provides more detail on specific modifications for each item.

Table 3-3. Modification Actions Summary

Action	Number Required (on 34 Units)
Vibration protection	30
Improved cooling	9
Substitute materials	27
Toxics bakeout	30
9-g integrity measures	10
EMI attenuation	10
Shatterables containment	18
Edges-protrusions guards/rounding	32
Functional redesign (zero-g)	9*
Audible noise reduction	4
*3 units require complete new design	

Some vibration protection was needed for almost all units. Testing could show a greater or lesser need for redesigns. Final Spacelab definition and shockmount studies may also change the severity of the problem. Without providing much greater depth of analysis on each unit, the modifications defined can only be categorized as "representative" for cost study purposes. Resonance and cross-axis effects, etc., could result in some rather sturdy-appearing mounts to be insufficient.

Surprisingly few cooling modifications were identified. Many units had self-contained forced-air fans and good air flow paths. These same cooling fans generated noise in excess of the allowable 40 dB noise criteria in four cases. Airborne units are designed for conductance of heat to the case so that they can operate at altitudes up to 55,000 feet without internal air circulation. Most rack-mounted equipment items are vented to allow forced-air cooling in the rack installation. It was assumed that rack air could be supplied in parallel to each unit where needed.

Material substitutions were high due to conservative replacement of wiring, plastic panel knobs and fixtures if not positively identified as acceptable. By excluding knob replacement, only 20 items need material replacement. Only 13 units need other than knob/wiring-related replacements. These include 5 nixie tubes which contain trace accounts of mercury. Likewise, toxic bakeout

was assumed to be necessary for all units containing organics in order to preclude heavy initial outgassing from components, solvent cleaners, process catalyzers, etc.

EMI provisions were generally satisfactory based on a ferromagnetic case and input/output circuit compatibility with assumed Spacelab EMI grounding and cabling practices. Modifications were required for 10 units.

Slightly more than one-half the units contained glass shatterables requiring added containment or replacement. Most units had exposed sharp edges and protrusions. Control panel knobs were considered to be protrusions. Handles and guards were generally judged to be inadequate. Redesigned guard rails were assigned to the units, but could be part of the rack design.

Finally, several biomedical systems use open vials in sample handling (pH meter, electrophoresis system, blood cell counter, and spectrophotometer) or mechanical gravity seating (microscope) and require functional redesign. The freezer and dewar depend upon gravity for vapor phase separation processes. These units and the Coulter counter were not amenable to modification; i.e., a different operating principle must be used, requiring total new developments.

3.2.4 Suitability Analysis Conclusions

As might be expected, the most significant modifications appear to be for vibration integrity and replacement of unsuitable materials. However, both areas require test verification and further in-depth study because:

1. The final criteria to be met have not been established. Trade studies discussed in Section 4.3 indicate a benefit for Spacelab to provide a better environment than given by SEEIR.

2. Both characteristics are difficult to evaluate by inspection. Vibration effects are complex; resonances could exist at locations which are difficult to predict. Materials could not frequently be identified because of inadequate supplier information, which will be the case for the actual selections of equipment items. A better definition of allowable risks due to Spacelab safety features should be pursued.

Rockwell experience indicates that ATR, MIL or NIM-type equipment items have inherent design characteristics needing few modifications. Chemical and biomedical equipments tend to be less suitable because most have been designed for sensitive laboratory work in a benign environment. Also, test samples are commonly liquid, utilizing gravity during processing.

3.3 EQUIPMENT DESIGN MODIFICATIONS

This section summarizes the efforts and results related to specific modification designs and processes required to make suitable those equipment items found to be unsuitable. As the study progressed, certain unsuitabilities and redesign situations became repetitious. A set of standard design guidelines evolved and were used to help assure consistent design changes which, in turn,

led to a more consistent cost analysis. The design guidelines are presented in Section 3.3.1. A summary of recommended processes is presented in Section 3.3.2.

3.3.1 Standard Design Guidelines

The following guidelines were established to enable consistent costing for similar equipment unsuitabilities. The application of specific guidelines may not necessarily be the best redesign approach in some cases. However, they are adequate to assure proper cost estimates for modified hardware. Equipment also required non-typical modifications not covered by the guidelines. Such unique designs are found in Volume III under the modification description section for each item.

3.3.1.1 ARINC-To-NIM Conversion

Since all ATR (ARINC) cases have a standard 7.625 in. (19.4 cm) maximum height, they will fit inside a NIM (nuclear instrumentation module) bin of the 8-3/4 in. (22.2 cm) type whose front opening height is 7.785 in. (20 cm). The ATR case is modified by the addition of a front panel and side panels which provide top and bottom runners which mate with the guides in the NIM bin as shown in Figure 3-22. The connector mounting plate in the rear of the NIM bin is removed in the area where the over-long ATR case protrudes.

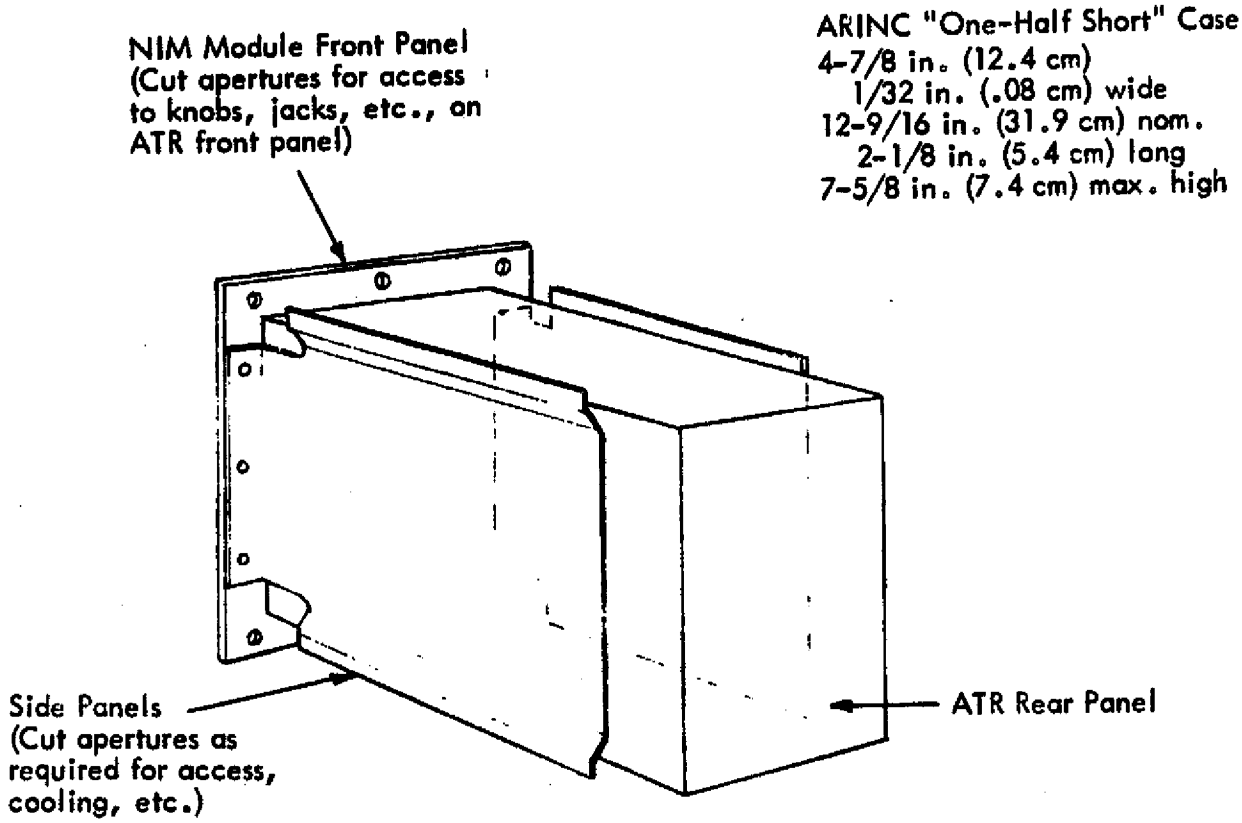

Figure 3-22. ARINC-To-NIM Conversion

3.3.1.2 Cable Clamps and Tie-Wraps

Cable clamps and tie-wraps must be nylon. Unsupported lengths of cable bundles and single wires must be secured. Wires going through holes in metal bulkheads must be protected by nylon grommets.

3.3.1.3 Card Guides - Printed Circuit Boards

Card guides which do not provide vibration protection must be replaced with spring clip guides which provide support as well as high-frequency isolation and good thermal conductivity. See Figure 3-23.

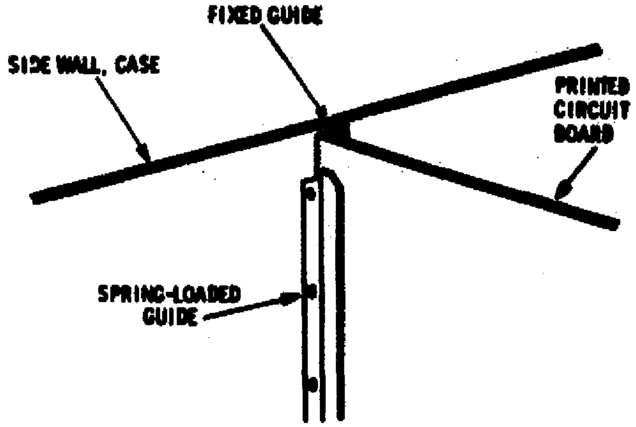

Figure 3-23. Card Guide, Printed Circuit - Positive Securing

3.3.1.4 Component Clips

Lead-mounted components over 4.0 grams shall be supported by rivet-mounted metallic clips as shown in Figure 3-24. Where clips may short out conductor lines of the printed circuit, a thin glass epoxy insulator must be placed between the clip and the board surface.

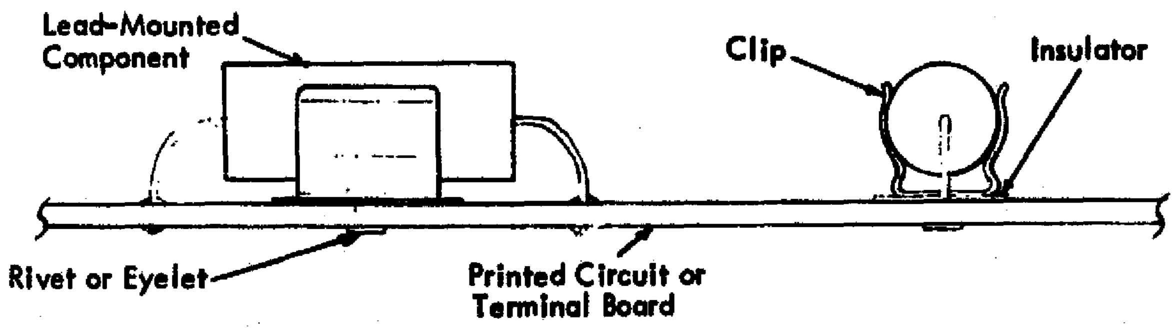

Figure 3-24. Component Clips

3.3.1.5 Fasteners (Vibration-Proof)

All structural fasteners must be those with thread-locking features. An epoxy formulation may be used, such as "Glyptol," in nonstructural situations such as potentiometer locking, etc. Thumbscrews require replacement or safety wiring. Cantilevered items needing support will have brackets to available solid structure to which component is mounted.

3.3.1.6 Glass Viewing Covers

Meter faces, CRT shields, etc., must be replaced with transparent Lexan when not identified as acceptable.

3.3.1.7 Material/Hardware Replacement

Wire harness and other PVC parts will be replaced with Teflon. Cadmium-plated chassis must be stripped and replated or reformed of new non-cadmium material. All panel knobs are to be of custom-fabricated Vespel with steel shaft inserts and double shaft set screw fasteners, staked to prevent loosening in vibration. Metal knobs are also acceptable. It will be assumed that (except in unusual circumstances) no transformers or other electrical components will be replaced for chemical composition reasons. Where required, and dependent upon individual circumstances, components will be coated with a suitable material (e.g., epoxy).

3.3.1.8 Non-Rack-Mounted Instruments

Portable instruments, such as bench-top microscopes, must be secured in assigned stowage spaces when not in use. When used, provision must be made to (1) secure the instrument to a bench, and (2) ensure against injury to personnel and damage to the instrument. Securing of non-portable, non-rack-mounted instruments such as furnaces will be treated on an individual basis. Where necessary, the mount must provide for shock/vibration isolation and alignment caging. Size the structure per SEEIR safety factors to eliminate proof-testing.

3.3.1.9 Mechanical Securing of Rack-Mounted Instruments

Heavier instruments such as the 20-inch (50.8 cm) deep Sorenson power supply, with heavy transformers in the rear of the unit, and units weighing over 30 pounds (13.6 kg) will require additional mechanical support. This will be accomplished by addition of tapered-pin assemblies attached to the rear of the instrument, and modification of the rack assembly to accept the tapered pins, plus appropriate guide rails, as illustrated in Figure 3-25. Catalog off-the-shelf mounts may be used when satisfactory for the 9-g crash load and worst case vibration. Structure sizing is per SEEIR safety factors to eliminate proof-testing.

3.3.1.10 Printed Circuit Board Securing

Printed circuit assemblies and terminal boards requiring additional support to prevent oil-canning or vibration must use drilled and tapped

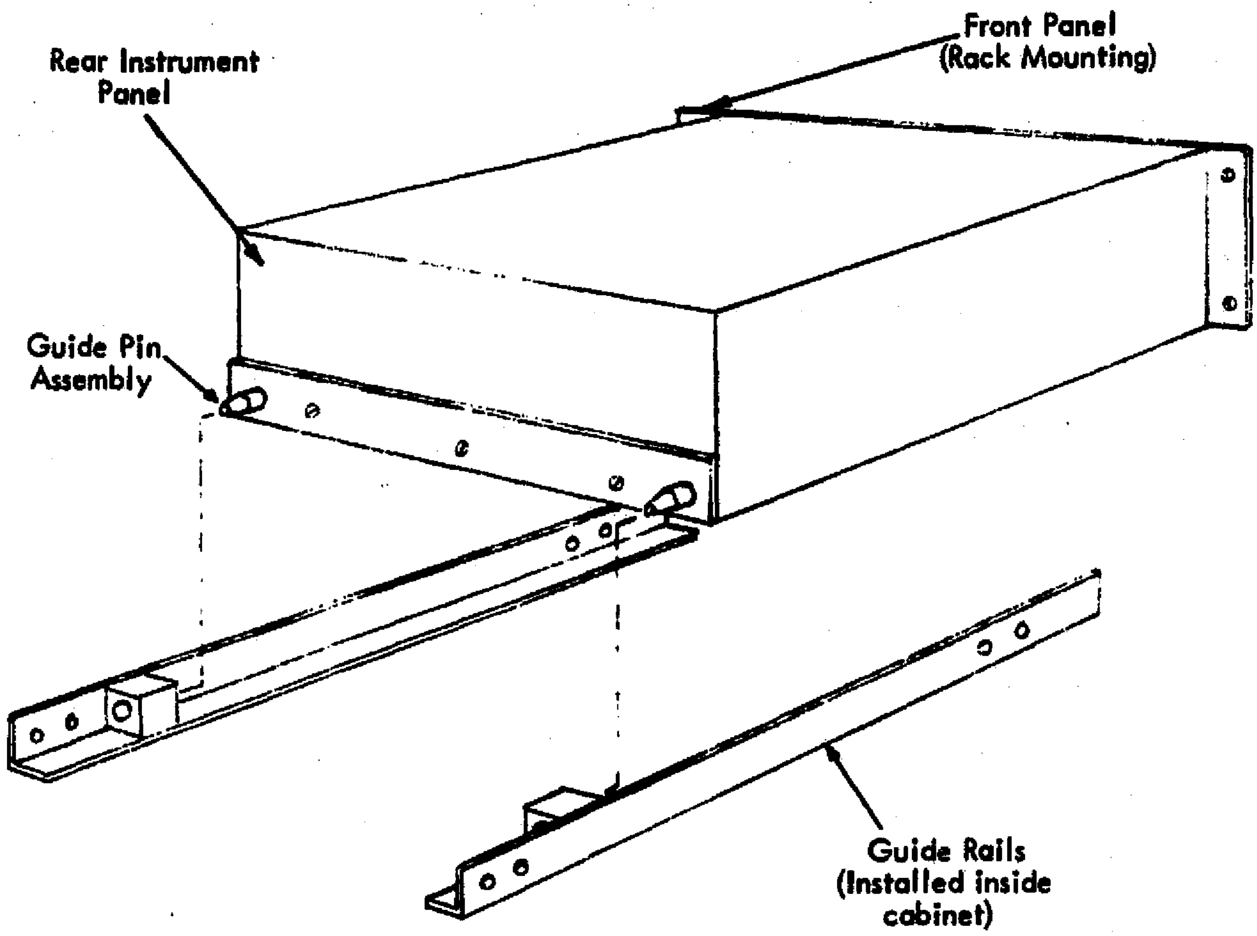

Figure 3-25. Mechanical Securing
of Heavy Rack-Mounted Instruments

standoffs which can be attached to a convenient bulkhead. In locations where a metallic standoff would short out printed circuit conductors, rectangular blocks of glass epoxy may be used as shown in Figure 3-26. The blocks are to be attached with low curing-temperature epoxy adhesive.

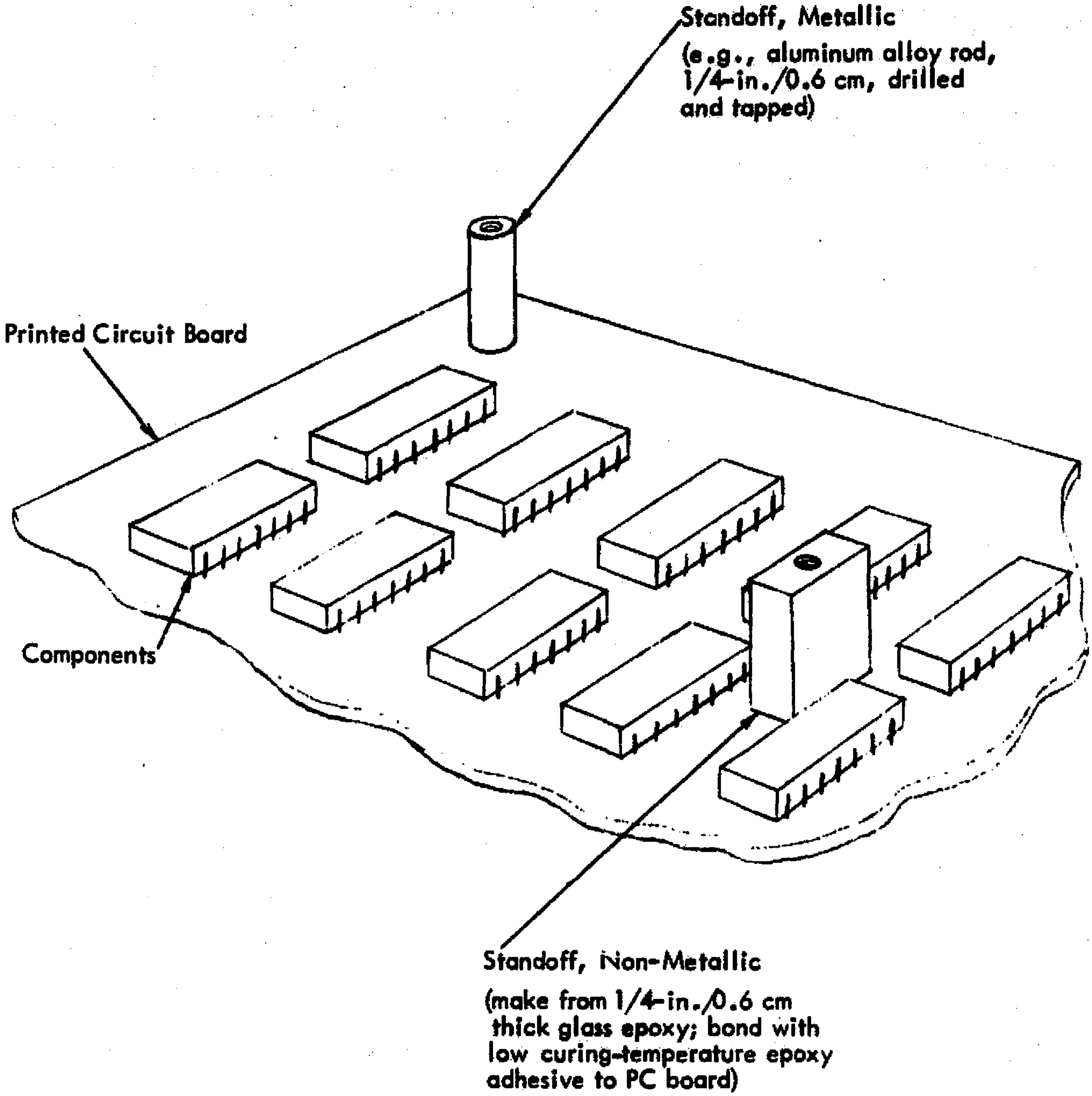

Figure 3-26. Mechanical Securing - Printed Circuit Boards

3.3.1.11 Protrusion Protection

The prevention of injury to personnel due to zero-g collisions with knobs, switches, etc., on the front panels of rack-mounted instruments will be accomplished by a modification of the rack cabinet consisting of rails or handles mounted horizontally across the front of the cabinets. The rails, 1.0 in. (2.5 cm) in diameter, will be secured to the exposed vertical section of the cabinets; see Figure 3-27. They will extend far enough out from the front panels of the instrument, e.g. 2-1/2 in. (6.3 cm), that in any accidental encounter by personnel the rails would be contacted before any knobs, switches, etc. The rails will be so located that they will not obscure the view or interfere with any function of the instruments. Edge protection on non-rack-mounted items will be by fastening a rolled tubing or extruded plastic along the edge by an attachment flange which is drilled, screwed, and staked for vibration.

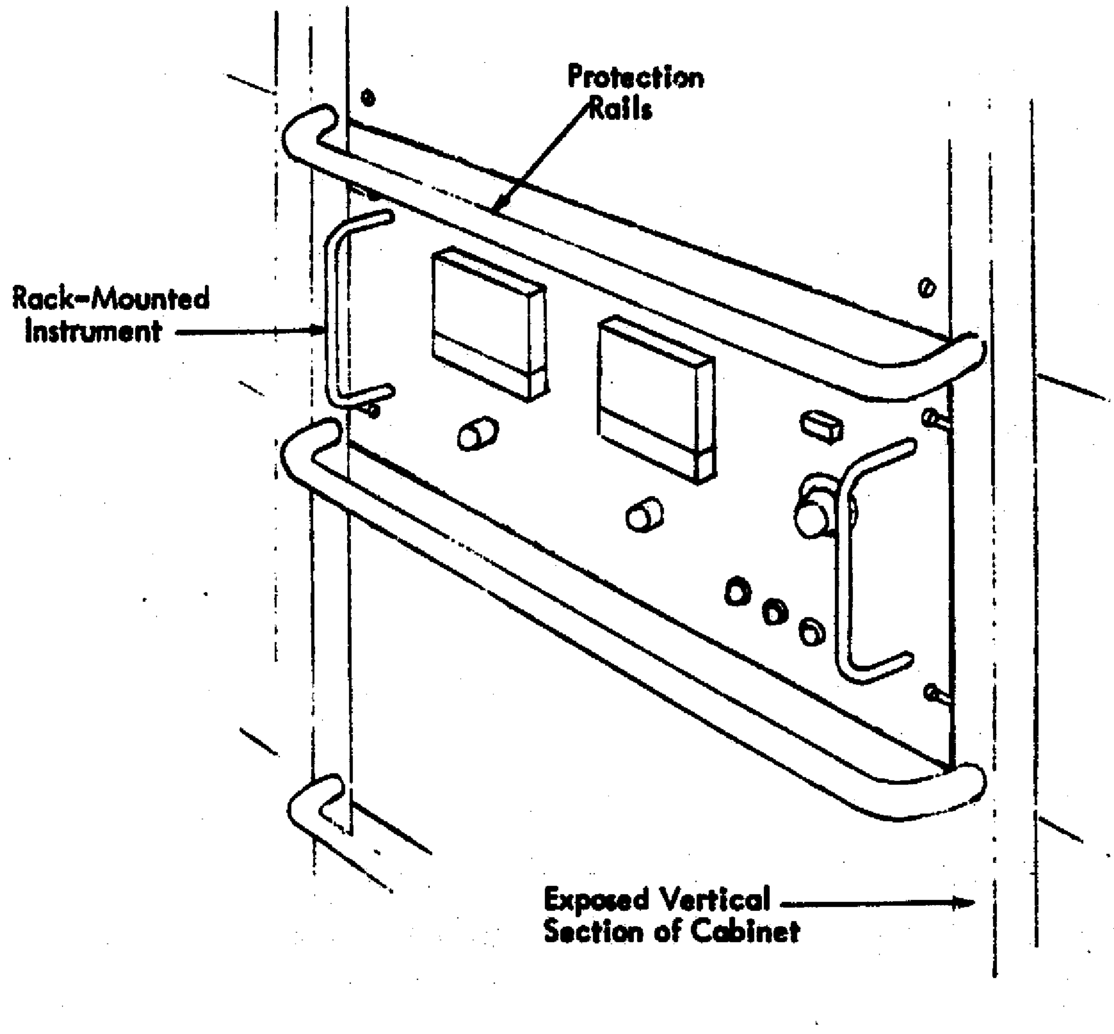

Figure 3-27. Protrusion Protection

3.3.1.12 Venting of Chassis, Covers, or Bulkheads

Forced convection cooling and elimination of pressurization hazards dictate venting where required. Where glass components such as CRT's are involved, cover inside of vents with metallic fine-mesh screen at the most convenient enclosure that would contain any fragments.

3.3.1.13 Modification Certification

All modified equipment items require acceptance testing. Additional criteria to verify safety and performance requirements compatible with Spacelab are applied.

3.3.1.14 Chassis/Signal Return Grounds

Isolate all circuit boards and other components grounded to chassis through mounting screws by using insulating washer kits. Remove all wired grounds to the chassis. Interconnect all isolated returns to a bus wire, going through connector pins as necessary.

3.3.2 Summary of Recommended Modifications

Table 3-4 summarizes the specific modifications accomplished for the 34 items analyzed. Included in the summary are the dewar, blood cell counter, and freezer which were not priced due to functional incompatibilities with zero g. Modifications to these items would be meaningless since they would necessitate custom-design efforts.

3.3.2.1 Staking

Fasteners on most items required positive retention to prevent loosening during vibration. Self-tapping or threaded-in screws and oversized holes/slots for holding structural members can quickly loosen and come apart or alter dynamic responses. Such screws were replaced by bolts or Locktite-type fasteners. Also, control panel knobs on some equipment items were push-on type or had a single screw for holding to control shafts. Knob set screws were staked with epoxy.

Some items have up to 80 potentiometer adjustments. If one or more adjustment shifts slightly during launch, the items' usefulness would likely be severely compromised. In-flight realignment is not recommended due to relative inaccessibility and lack of support equipment. Potentiometer adjustments were epoxied into place after calibration. Mechanical adjustments were few and appear to be relatively easy to readjust for the items inspected, although exceptions may be possible.

Wiring tie-downs were recommended to keep "flapping" wires from breaking at terminations.

The use of push-on thermal dissipation fins on transistors and IC's is relatively common. Some were tight-fitting, while others were found relatively insecure and could easily work loose causing a short or a component to overheat. Epoxy adhesive was placed on these fins to prevent them from loosening.

Table 3-4. Detailed Summary of Item Modifications

VIBRATION - SHOCK and EMI

Item	Staking: Screws	Staking: Knobs	Staking: Adjustments	Staking: Wiring	Staking: "Fins" (Thermal)	Staking: Other	Stiffen, Constrain: CKT Board(s)	Stiffen, Constrain: Assys/Chassis	Stiffen, Constrain: Cantilever Parts	Stiffen, Constrain: Connector Mating	MSC: Holding	MSC: Latching	Isolate: CKT Board(s)	Isolate: Other	EMI: Grnd Isol	EMI: Shields	EMI: I/O Char	EMI: I/O Connectors	EMI: Power Line (Port Units)
1. TAPE RECORDER-AMPEX AR700			X		X														
2. TAPE RECORDER-HONEYWELL 5600							X	X	X	X					X				
3. COMPUTER-DIGITAL EQPT PDP8E	X	X	X	X			X		X	X			X					X	
4. KEYBOARD DISPLAY TERM-ESHINC 21MW	X	X	X	X			X	X	X	X	X		X	X		X		X	
5. BLOODCELL COUNTER-COULTER FN	X	X	X	X		X	X	X	X	X	X	X	X	X					
6. TIMER-DAYTRON 3150	X	X	X				X		X					X					
7. EVENT COUNTER-TENNELEC	X	X	X	X	X		X		X		X								
8. SPECTROPHOTOMETER-BECKMAN 24	X	X	X	X			X	X	X	X	X		X	X					
9. BM METER(MCUR)-SINGER NM37/57		X	X						X				X		X		X		
10. VHF TRANSCEIVER-COLLINS 618M-2																			
11. L/C/X BAND XMITTER-RHG W1900																			
12. SIGNAL CONDITIONER(AMP)-NEFF 126	X	X		X			X		X	X	X		X						
13. ANALYZER(MULT CHAN)-NUCLEAR DATA 100	X	X	X	X			X	X	X		X		X						
14. RF SPECTRUM ANALY HP141T/8552/8555/8445		X	X		X		X	X	X		X		X		X				
15. RF SPECTRUM ANALY-SINGER SS8016		X	X				X				X		X		X				
16. FREQUENCY GENERATOR-FLUKE 645M		X	X														X		
17. LASER(W CO₂)-SYLVANIA 948									X					X					
18. GAS CHROMATOGRAPH-BECKMAN 6700	X	X	X				X	X	X	X	X	X	X		X				
19. MICROSCOPE-AMER OPT XN20T						X						X							X
20. STRIP CHART RECORDER-HONEYWELL 1858	X	X	X				X		X			X	X						
21. DIGITAL VOLTMETER-FLUKE 8200	X	X	X				X		X				X						
22. DIGITAL VM(MIL)-FLUKE 8125A	X	X	X				X		X		X		X						
23. OSCILLOSCOPE-TEKTRONIX 485	X	X	X		X		X		X	X	X				X				
24. OSCILLOSCOPE(MIL)-HP AN/USM-291A	X	X	X				X		X				X						
25. ELECTROPHORESIS SYST-BECKMAN R	X	X	X	X			X		X		X	X	X						
26. ELECT VAC FURNACE-ASTRO 1000	X					X					X	X							
27. DEWAR-CRYO ASSOC IR-90		X				X													
28. POWER SUPPLY-SORENSON SLR60-12	X	X	X				X		X		X								
29. HIGH PWR SUPPLY-PWR DESIGNS-AEC320-3	X		X				X		X		X		X						
30. CENTRIFUGE-CLAY ADAMS CT1004	X	X		X		X						X							
31. FREEZER-REVCO ULT-185A	X	X		X		X		X	X		X	X		X	X	X			X
32. EVENT COUNTER ASSY-ORTEC (406, 409A, 435, 415, 416)	X	X	X	X			X		X										
33. MICROTOME-AMER OPT 820	X	X	X			X					X	X							
34. PH METER-BECKMAN PHASAR II	X	X	X	X			X	X	X	X	X		X						
TOTAL ITEMS AFFECTED	23	26	24	12	6	7	22	9	24	9	18	9	17	5	7	2		2	2

MATERIALS and ZERO-G COMPATIBILITY

Item	Replacements: Knobs	Replacements: Wire Harness	Replacements: Case	Replacements: "View" Glass	Replacements: Foam	Replacements: Mercury	Replacements: Cadmium	Replacements: Other	Seal	Encapsulate	Zero-G: Functional	Zero-G: "Loose" Parts	Thermal: Porting	Thermal: Other
1. TAPE RECORDER-AMPEX AR700														
2. TAPE RECORDER-HONEYWELL 5600		X								X				
3. COMPUTER-DIGITAL EQPT PDP8E	X	X								X				
4. KEYBOARD DISPLAY TERM-ESHINC 21MW		X		X			X	X		X			X	
5. BLOODCELL COUNTER-COULTER FN	X	X		X	X	X	X		X	X	X	X	X	X
6. TIMER-DAYTRON 3150	X	X		X		X				X				
7. EVENT COUNTER-TENNELEC	X									X				
8. SPECTROPHOTOMETER-BECKMAN 24	X	X			X	X			X	X	X	X	X	
9. BM METER(MCUR)-SINGER NM37/57	X			X	X									
10. VHF TRANSCEIVER-COLLINS 618M-2														
11. L/C/X BAND XMITTER-RHG W1900														
12. SIGNAL CONDITIONER(AMP)-NEFF 126										X				
13. ANALYZER(MULT CHAN)-NUCLEAR DATA 100	X	X								X				
14. RF SPECTRUM ANALY HP141T/8552/8555/8445	X	X								X				
15. RF SPECTRUM ANALY-SINGER SS8016	X													
16. FREQUENCY GENERATOR-FLUKE 645M	X													
17. LASER(W CO₂)-SYLVANIA 948														
18. GAS CHROMATOGRAPH-BECKMAN 6700	X	X						X		X				
19. MICROSCOPE-AMER OPT XN20T								X			X	X		X
20. STRIP CHART RECORDER-HONEYWELL 1858	X	X								X	X			X
21. DIGITAL VOLTMETER-FLUKE 8200	X	X	X	X		X				X			X	
22. DIGITAL VM(MIL)-FLUKE 8125A				X		X				X				
23. OSCILLOSCOPE-TEKTRONIX 485	X	X								X				
24. OSCILLOSCOPE(MIL)-HP AN/USM-291A	X	X								X			X	
25. ELECTROPHORESIS SYST-BECKMAN R	X	X								X	X		X	
26. ELECT VAC FURNACE-ASTRO 1000	X											X		
27. DEWAR-CRYO ASSOC IR-90	X			X							X	X		
28. POWER SUPPLY-SORENSON SLR60-12	X	X		X						X				X
29. HIGH PWR SUPPLY-PWR DESIGNS-AEC320-3							X			X				
30. CENTRIFUGE-CLAY ADAMS CT1004								X			X	X		
31. FREEZER-REVCO ULT-185A	X	X		X	X			X			X			X
32. EVENT COUNTER ASSY-ORTEC (406, 409A, 435, 415, 416)	X						X			X				
33. MICROTOME-AMER OPT 820	X							X				X		
34. PH METER-BECKMAN PHASAR II	X	X	X				X			X	X	X	X	
TOTAL ITEMS AFFECTED	23	17	2	9	4		5	6	2	21	9	6	7	5

CRASH INTEGRITY and AUDIBLE NOISE

Item	Item: Doors	Item: Module Attachments	Item: Parts (Ch. Dis Not Incld)	Item: Attachments	Item Mounting: New Rqmt	Item Mounting: Mod Rqmt	Item Mounting: Catalog	Item Mounting: Hard Mt	Item Mounting: Shock Mt	Item Mounting: Crit Alane	Item Mounting: Store	Source: Motor (Fan)	Source: Other	Type: Continuous	Type: Occasional
1. TAPE RECORDER-AMPEX AR700					X				X						X
2. TAPE RECORDER-HONEYWELL 5600							X		X			X		X	X
3. COMPUTER-DIGITAL EQPT PDP8E					X				X			X		X	
4. KEYBOARD DISPLAY TERM-ESHINC 21MW			X		X				X						
5. BLOODCELL COUNTER-COULTER FN			X		X			X							
6. TIMER-DAYTRON 3150							X		X						
7. EVENT COUNTER-TENNELEC		X				X			X						
8. SPECTROPHOTOMETER-BECKMAN 24			X		X			X							
9. BM METER(MCUR)-SINGER NM37/57							X		X						
10. VHF TRANSCEIVER-COLLINS 618M-2					X				X						
11. L/C/X BAND XMITTER-RHG W1900							X		X						
12. SIGNAL CONDITIONER(AMP)-NEFF 126		X					X		X						
13. ANALYZER(MULT CHAN)-NUCLEAR DATA 100		X				X			X			X		X	
14. RF SPECTRUM ANALY HP141T/8552/8555/8445		X				X			X			X		X	
15. RF SPECTRUM ANALY-SINGER SS8016		X				X			X						
16. FREQUENCY GENERATOR-FLUKE 645M						X			X						
17. LASER(W CO₂)-SYLVANIA 948				X	X			X		X					
18. GAS CHROMATOGRAPH-BECKMAN 6700	X				X^A	X^P			X						
19. MICROSCOPE-AMER OPT XN20T			X		X						X				
20. STRIP CHART RECORDER-HONEYWELL 1858		X				X			X						
21. DIGITAL VOLTMETER-FLUKE 8200					X				X						
22. DIGITAL VM(MIL)-FLUKE 8125A					X				X						
23. OSCILLOSCOPE-TEKTRONIX 485		X			X				X						
24. OSCILLOSCOPE(MIL)-HP AN/USM-291A		X			X				X						
25. ELECTROPHORESIS SYST-BECKMAN R	X				X			X			X				
26. ELECT VAC FURNACE-ASTRO 1000			X	X	X			X							
27. DEWAR-CRYO ASSOC IR-90			X		X						X				
28. POWER SUPPLY-SORENSON SLR60-12						X			X						
29. HIGH PWR SUPPLY-PWR DESIGNS-AEC320-3		X				X			X						
30. CENTRIFUGE-CLAY ADAMS CT1004	X				X			X							X
31. FREEZER-REVCO ULT-185A	X		X		X			X				X		X	
32. EVENT COUNTER ASSY-ORTEC (406, 409A, 435, 415, 416)		X				X			X						
33. MICROTOME-AMER OPT 820	X		X		X			X							
34. PH METER-BECKMAN PHASAR II		X			X				X						
TOTAL ITEMS AFFECTED	5	11	8	2	20	10	3	8	24	1	3	5	0	5	3

BAKEOUT, ADDED COOLING, SHATTERABLE PARTICLES, PERSONNEL PROTECTION and NOTES

Item	Bakeout (Case Exhaust For): Sealed	Bakeout: Open	Bakeout: Fan	Added Cooling: Porting	Added Cooling: Fan(s)	Added Cooling: Radiators	Added Cooling: Sinks/Exchangers	Added Cooling: Directors, Etc	Added Cooling: H₂O, Other	Shatterable Particles Flamming Droplets Protection: Protect View Cover	Shatterable: Inner Screens	Shatterable: Case Screens	Shatterable: Replace Items	Shatterable: Encapsulate	Personnel Protection: Edge/Corner	Personnel Protection: Prohibition	Notes
1. TAPE RECORDER-AMPEX AR700	X															X	
2. TAPE RECORDER-HONEYWELL 5600		X	X		X								X	X		X	
3. COMPUTER-DIGITAL EQPT PDP8E		X	X										X	X		X	
4. KEYBOARD DISPLAY TERM-ESHINC 21MW		X		X						X			X	X		X	
5. BLOODCELL COUNTER-COULTER FN		X		X			X	X		X	X	X	X	X	X		
6. TIMER-DAYTRON 3150		X								X		X	X	X		X	
7. EVENT COUNTER-TENNELEC		X												X		X	
8. SPECTROPHOTOMETER-BECKMAN 24			X		X		X					X		X	X		
9. BM METER(MCUR)-SINGER NM37/57	X									X						X	
10. VHF TRANSCEIVER-COLLINS 618M-2	X															X	
11. L/C/X BAND XMITTER-RHG W1900	X		X													X	
12. SIGNAL CONDITIONER(AMP)-NEFF 126		X												X		X	
13. ANALYZER(MULT CHAN)-NUCLEAR DATA 100			X							X	X			X		X	
14. RF SPECTRUM ANALY HP141T/8552/8555/8445			X							X	X			X		X	
15. RF SPECTRUM ANALY-SINGER SS8016	X									X						X	
16. FREQUENCY GENERATOR-FLUKE 645M	X							X								X	
17. LASER(W CO₂)-SYLVANIA 948	X														X	X	(A)ANALYZER
18. GAS CHROMATOGRAPH-BECKMAN 6700	X^A		X^P							X				X		X	(P)PROGRAMMER
19. MICROSCOPE-AMER OPT XN20T								X		X						X	
20. STRIP CHART RECORDER-HONEYWELL 1858		X	X	X				X			X			X		X	
21. DIGITAL VOLTMETER-FLUKE 8200		X		X						X		X		X		X	
22. DIGITAL VM(MIL)-FLUKE 8125A	X									X						X	
23. OSCILLOSCOPE-TEKTRONIX 485			X							X	X			X		X	
24. OSCILLOSCOPE(MIL)-HP AN/USM-291A		X		X								X		X		X	
25. ELECTROPHORESIS SYST-BECKMAN R		X	X	X								X		X	X		
26. ELECT VAC FURNACE-ASTRO 1000																X	
27. DEWAR-CRYO ASSOC IR-90										X						X	
28. POWER SUPPLY-SORENSON SLR60-12		X						X		X				X		X	
29. HIGH PWR SUPPLY-PWR DESIGNS-AEC320-3		X									X			X			
30. CENTRIFUGE-CLAY ADAMS CT1004	X											X			X		
31. FREEZER-REVCO ULT-185A		X	X					X	X	X					X	X	
32. EVENT COUNTER ASSY-ORTEC (406, 409A, 435, 415, 416)		X								X	X			X		X	
33. MICROTOME-AMER OPT 820															X		
34. PH METER-BECKMAN PHASAR II		X		X						X	X			X		X	STORE-CELLS
TOTAL ITEMS AFFECTED	10	16	11	7	2	0	3	6	1	17	8	7	5	20	7	28	

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3.3.2.2 Circuit Board and Parts Stiffening

Most circuit boards were judged to be in need of added support to reduce deflections. The size of the board, mounting, mass, and mass distribution largely determines the dynamic response. Solutions included firm but resilient guide/holding rails, braces across the board, and added center post mounting standoffs for bolted-down boards. Parts mounted on the boards were also often judged in need of support. Typical military-style clips, ties and/or conformal coating provided such support. Board encapsulation is discussed further in Section 3.3.3.

3.3.2.3 Other Supports

Large parts, such as transformers, mounted on flat-plate chassis, and end-mounted parts creating cantilevered masses, required custom braces to reduce secondary resonances and damaging torques to base mounts. In a few cases, doors or modules were judged not reliably latched to assure retention during launch and/or reentry. Each design modification was customed for the situation. Additionally, some equipment items utilize connectors that do not have positive engagement. Suitable connectors and/or special brackets were installed in these cases.

3.3.2.4 Electromagnetic Interference (EMI)

Chassis and signal ground isolation and input/output circuit voltage and impedance characteristics are the main areas of concern. Several units had single-point connections of signal/power ground to chassis (usually at the power supply) which can be easily corrected. Others (particularly spectrum analyzers) have multiple point grounding at circuit board mountings, connectors, etc. These units require separate ground buses throughout the unit. This could adversely affect performance of some units and either the requirement may need waiving, with suitable noise filters added, or a different design selected.

A few items required one or more buffer amplifiers added to the output to achieve the required 5-volt signal levels. These changes could be waived with good external cabling practices, assuming that the Spacelab remote acquisition units (RAU's) can accommodate wide-range interfaces. Although IC amplifiers are envisioned in most cases, power supply voltages, space and other factors could make this type modification relatively difficult.

3.3.2.5 Material Replacement

Wire harnesses required the most frequent replacement because PVC insulated wire is commonly used on commercial units. Modification difficulty varies with the unit as some harnesses are accessible by removing all plug-in assemblies, while others are hardwired and/or require nut and bolt disassembly for changeout. Some harnesses are suitable for prefabrication while others require point-to-point rewiring.

All plastic knobs required replacement. Metal or Vespel knobs were identified as replacements.

Viewing windows, such as meter faces, made of glass were modified. Glass faces were replaced or covered with a Lexan-type plastic to contain shatterables.

Foam materials used for vibration isolation, anti-rattle packing between modules, and hold-down bars and around case and door lips were replaced with non-flammable foam. Significant foam insulation replacement on the freezer chest would also be required, however, its modification became impractical for functional reasons.

It was determined that nixie tubes generally contain a trace of mercury to prolong cathode life. Four items examined (other than the blood cell counter) contain nixies. Life of tubes without mercury was reported to be only about 500 hours, or more than an order of magnitude less than those with mercury traces. Alternatives are to decide that the mercury traces are insignificant risk, use the shorter-life tubes, or develop a direct replacement using light-emitting diodes (LED's) with integrated circuit (IC) logic drivers on a nixie-sized plug-in circuit. The Navy is reportedly working on this problem due to concern of nixie tubes being used on submarines. Units were modified by installing non-mercury type nixie tubes and replacing them after each mission.

Cadmium-plated chassis were identified in three units; however, cadmium may be more extensively used than the evaluation suggests since some overfinishes concealed the base material. Several other units have small cadmium-plated parts such as brackets. Absolute prohibition could significantly increase modification costs for some equipment unless the modifications can be made during original buildup. An effort should be made to determine whether cadmium plating can be acceptably modified by a special process.

Other specialized replacements included change of asbestos insulation in the gas chromatograph and rubber bumpers/feet on certain bench-mounted units.

3.3.2.6 Zero-G Compatibility

It was found that the blood cell counter, freezer and dewar were functionally unsuitable for zero-g operation (see Section 3.2.3). Also, there were other very extensive modifications for the counter and freezer. Therefore, new functional approaches were deemed necessary.

Several other items require less extensive modifications to operate in a zero-g environment. The microscope requires addition of a spring to replace gravity seating of the barrel. The biomedical items require redesigned liquid sample handling/container methods. Basically, the electronics associated with the sample sensors are suitable for zero g. Strip chart recorders, such as the CRT recorder and the densitometer in the electrophoresis system, need chart paper guides/rollers to constrain output paper from "flapping" around and/or getting out of the existing guides.

3.3.2.7 Item Mounting and Integrity

Except for input probe accessories and latches on some doors, the items appear well suited to withstand 9-g acceleration forces. Cathode ray tubes are generally well supported, but Lexan overlays and screening were added to eliminate hazards if implosion should occur.

It was determined that many catalog rack guide mounts may be inadequate since they are seldom intended for the vibration or acceleration anticipated. Guide rails with a rear lock-down feature were added for dynamics considerations and to facilitate installation and removal on the ground. If the item face panel fits a 19-in. (48.2 cm) rack, the rail kit was the recommended modification. If a face panel bracket or other feature is also needed (i.e., to fit a NIM bin), then a new mounting design was defined. This distinction is made in the "Item Mounting" column of Table 3-4.

3.3.2.8 Audible Noise

Noise was considered to be a problem only if continuous during item operation. Noisy fans were replaced with quieter units. These replacements may have been conservative since the units were evaluated in the open by themselves. An alternative to replacing noisy fans would be to supply equivalent cooling air, from rack forced-air sources, directly to the fan inlets. The fans could be removed. However, provisions for tight connections and flex ducting, or other design solutions, would be necessary.

Since forced air is provided by the rack to each item, few modifications for cooling were required. Units with dead air spaces were modified with additional porting or air deflectors.

Units using fans expel air from the sides and/or top of the units. Baffles and spacing in the rack will be needed to ensure proper cooling air distribution.

3.3.2.9 Particle Containment

The main sources of possible shattered particles were CRT's. A few glass tube "auto" fuses in open clips were also identified. Exposed powdered iron core transformers and meter faces were other possible fragment sources. Containment of shattered and flaming particles (in case of breakage or ignition) was accomplished by covering all openings with clear-viewing plastic or mesh screen, as appropriate. Optimum screen mesh size is subject to further definition. The allowable size of escaping solid particle, the size versus burning time (or travel distance) of flaming droplets, and the stopping mechanism of a filter screen, bear upon this optimization. Such an analysis is beyond the scope of this study.

In general, ported cases use holes of about 3/16 in. (0.48 cm) diameter, or slots 1/8 (0.32 cm) to 3/16 in. (0.48 cm) by 1.0 in. (2.5 cm) long, for which screens were assumed to be needed. Internal screens were applied to openings in CRT shields, which generally completely enclose the CRT except for the socket end and the high-voltage cable entrace.

3.3.3 Summary of Recommended Processes

Special processes recommended for meeting SEEIR are as follows:

1. Coat circuit boards with a conformal coating to encapsulate unknown materials and provide additional support to lead-mounted components.

2. Spray painted surfaces, prone to flaking, with clear adhesive/binder.

3. Bake out unit to drive off trace contaminants.

In addition, tests are required in general for:

1. Verification of modification adequacy.

2. Tests may also be required to resolve whether a marginal design is adequate or requires modification.

3.3.3.1 Flame Retardant

Use of a flame-retardant coating is primarily intended for electronic circuit boards. Certain fiberglass-epoxy boards are non-flammable and, when so identified, may not require treatment unless undue concentrations of potential flammable plastic parts are loaded on them. In general, except for high-voltage CRT circuits, all items that were evaluated operate on low circuit voltages ($\pm$24 vdc or less) once past the input power transformer. All electrical items were fused. No items contained volatile chemicals. Therefore, it appears that the risk of ignition within almost all off-the-shelf items is very low. The presence of high voltages and bundled wiring somewhat increases the risk due to the increased chances of heat-generating leakage current paths.

An encapsulant may also be applicable to transformers. Many commercial items utilize open-frame construction with a slightly higher risk of generating smoke (if not flames) from small amounts of exposed "fish" paper and insulation varnishes. Assuming that heat dissipation is not adversely affected, these transformers could be coated in areas of exposed windings/fishpaper. The effect and suitability of this process should be among test objectives on representative equipment items purchased to verify modification feasibility and ultimate suitability for Spacelab use.

As noted previously, a conservative modification costing stance was adopted; therefore, all electronic boards are assumed to be coated with flame-retardant material, except in totally enclosed units where combustion would be limited. However, inasmuch as most boards also require encapsulation for vibration, there is no added cost delta for flame retardant.

3.3.3.2 Vibration Encapsulation

Current judgment is that most off-the-shelf electronic circuit boards cannot withstand the random-plus-sinusoidal vibration specifications placed in SEEIR without failure. Some relatively large-mass lead-mounted components may pull loose from circuit board solder joints or leads may break. A solution to supporting small parts is to coat the circuit boards with an encapsulant that lends lateral and longitudinal support to small components. Adjustments, however, should not be coated for continued usefulness (separate staking of these adjustments may be necessary).

The encapsulant should be tough, but not brittle. Pliability should compensate for differences in thermal coefficients of expansion for the encapsulant and the encompassed parts to prevent component breakage and adverse shifting of components with temperature. Shifting could affect performance in some RF circuits. Other requirements are good dielectric qualities, inertness to adjacent materials, low outgassing after curing, and non-flammability. Consultation with material experts indicates that acrylic or epoxy encapsulants with good outgassing and flammability characteristics can be provided.

To summarize, further study is recommended to:

1. Finalize vibration input specification to equipment items.

2. Develop "cook book" guides, including simple and inexpensive tests, to evaluate individual equipment modification needs.

3.3.3.3 Overspray (Painted Surfaces)

A clear overspray was assumed to be satisfactory for prevention of flaking of painted surfaces. This process avoids the necessity of reapply printed matter. In actual practice it appears that there will be little need for this process, owing to the relatively short missions and benign atmosphere that minimizes degradation of the painted surfaces. Further, it appears to be standard practice to use high-quality paints and applications on quality equipment items. These appear compatible with a Class 100,000 atmosphere or better. Most items inspected had painted front panels only. It is likely that if a flaking problem developed on a unit, it would generally be only after a number of missions. Pre-mission inspections and post-mission evaluations would avoid excessive problems on subsequent missions.

3.3.3.4 Expelling Trace Contaminants

Equipment containing organics, particularly plastics, may exude relatively large emissions of solvents, plasticizers, and other chemicals used in manufacturing processes. While some continued offgassing will occur as chemicals work to the surface of materials, it decreases significantly with time. Another source of offgassing is entrapment of solvents and cleaners that may be applied to assemblies or components before, during and after manufacture.

A recent study for NASA by Beckman on four commercial equipment items indicated that 150 hours of operation reduced outgassing to a relatively low, essentially constant level. This process was adopted as a general requirement for SEEIR.

3.3.3.5 Testing of Modified Hardware

It will be necessary to requalify/accept items that have been modified. Unless the SEEIR vibration values are reduced, it appears prudent to accomplish some type of vibration tests to verify ability to survive launch. Functional tests operating in six orientations have been successfully performed on the Apollo program to verify zero-g operational compatibility. A repeat of all normal functional tests will be required to assure no unintentional damage during the modification process. The cost analysis included necessary estimates for these activities.

3.4 COST ANALYSIS

3.4.1 Cost Analysis Approach

The approach employed to determine the cost of modified and custom-built hardware is pictorially depicted on Figure 3-28.

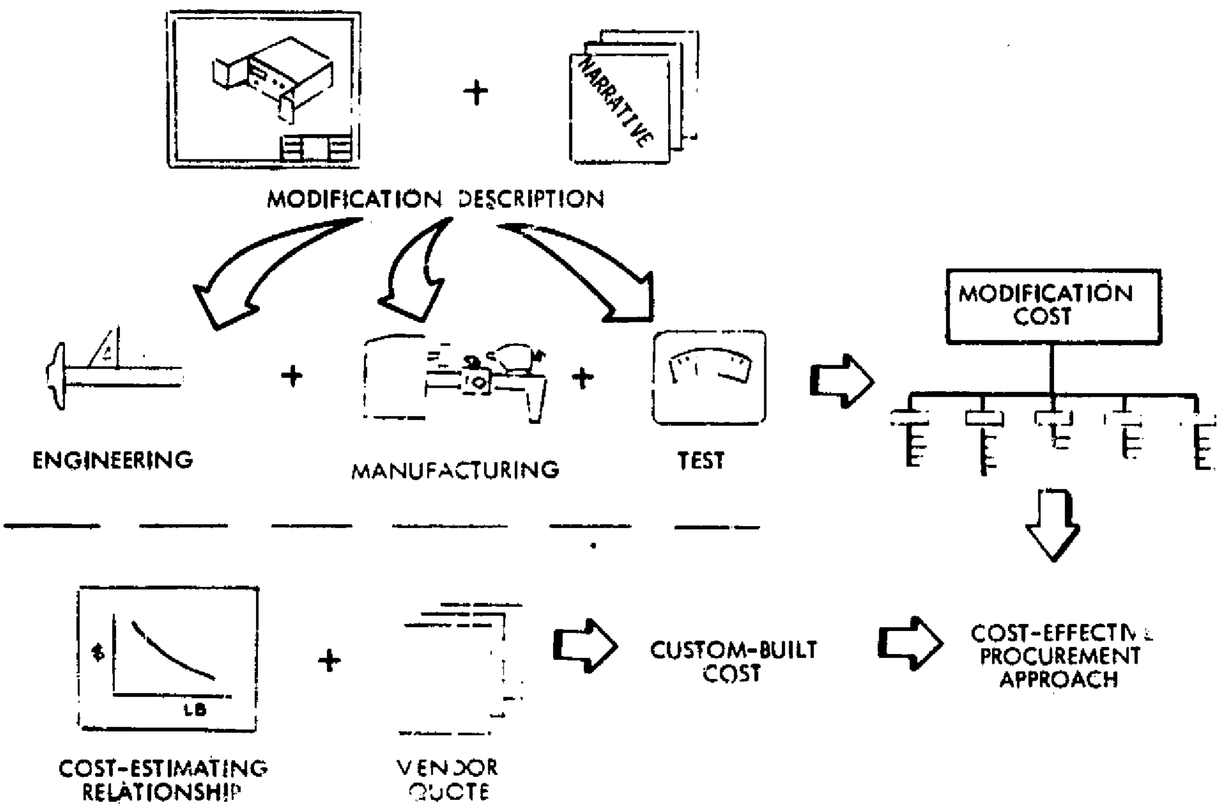


Figure 3-28. Cost Analysis Approach

Two separate costing activities were accomplished, leading to the selection of the cost-effective procurement approach for each item. Analytical techniques were different for both activities. Modified hardware costs were determined by a "grass roots" analysis which estimated the cost of each activity associated with the modification. Costs for custom-built hardware were estimated based on the traditional cost estimating relationship (CER) approach.

Analysis of modified hardware costs is dependent on the engineering description of the modification required to make each item suitable for installation aboard the Spacelab. Based on this information, engineering, manufacturing, test, and other costs were determined. These cost elements are summed up according to their location in the work breakdown structure defining the total modification costs. Custom costs were determined from either adjusted CER's or vendor quotes. Custom cost estimates were received from vendors for 6 of the 34 items.

3.4.1.1 Modified Equipment Costs

Modified hardware costs were determined by estimating the elemental cost incurred by the modification activity on each unit. The work breakdown structure for the costs of hardware modification is shown on Figure 3-29. Each cost category is identified along with the cost elements that make up that category. Costs were defined by cost element for engineering and manufacturing. Costs for verification testing includes testing, test fixtures, and operations. New test facilities were assumed not required. Documentation and project management estimates could not be determined at the level of their cost elements. These costs were determined at the category level, including the elements listed.

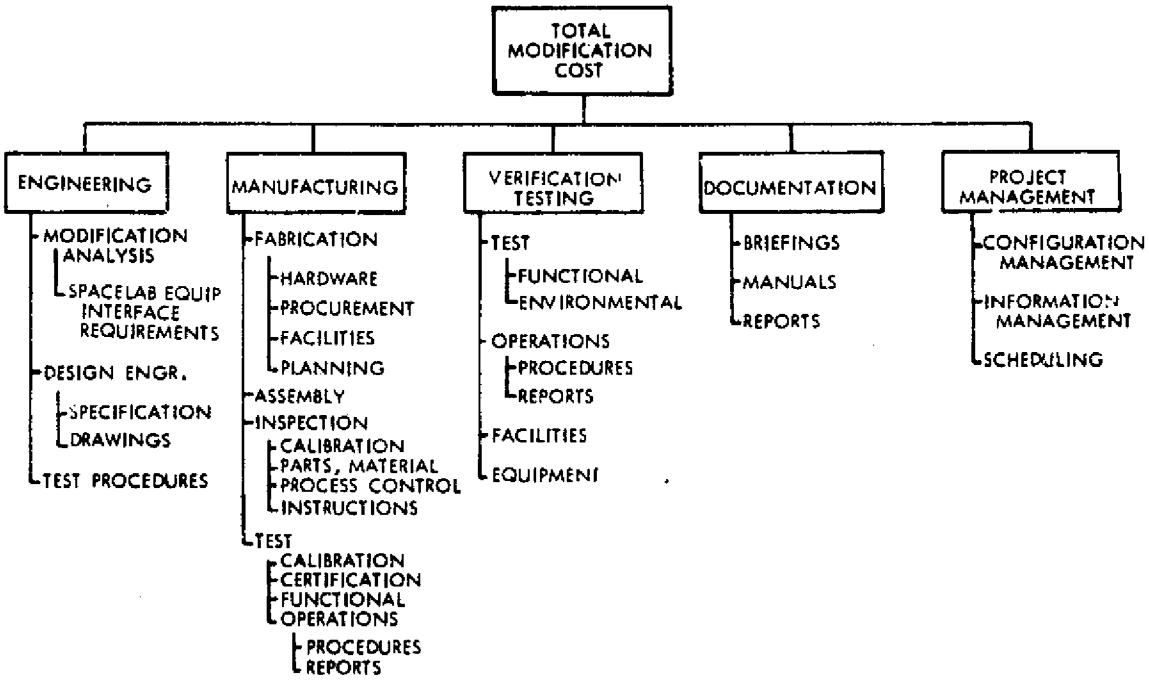


Figure 3-29. Work Breakdown Structure

In order to facilitate the detailed estimates required, engineering researched the available data on the selected hardware by reviewing sketches, drawings, photographs, and specifications; and visually examined as many units as possible. Drawings and narratives were prepared describing the necessary modifications needed to each piece of equipment to make it acceptable for use in the Spacelab. These data, along with photographs, were forwarded to Beckman Instruments for use in developing the manufacturing estimates.

Verification testing includes only tests to verify that the modifications performed on a given unit make the unit suitable for installation in the Spacelab. Characteristics analyzed to be suitable do not require verification testing.

Documentation costs include the cost of documentation not included in the engineering, manufacturing and testing activities. Documentation costs in these categories vary with modification activities. Costs in the documentation category cover general documentation requirements which tend to be more constant and less dependent upon the amount of modification undertaken.

Project management costs were considered to vary with the modification activity.

The sum of the costs by category define the cost of the modification activity. The total cost of modified hardware equals the retail cost plus this modification cost.

Engineering. Engineering hour estimates were generated by the responsible engineer, based upon his knowledge of the modification involved and the necessary engineering tasks. The estimates generated for each task were compared between items of equipment in order to reflect consistency from one to another. Where possible, estimates were based on historical data from other programs, such as an hours-per-drawing factor extracted from Saturn S-II data. A sample of the determination of engineering cost estimates is shown in Figure 3-30. The Tennelec Timer (Model TC 545), a supporting amplifier module, and a power supply module are used for the example.

A matrix of engineering tasks was employed to ensure consistency of engineering estimates. Seventy-one different tasks were identified for the 34 selected items. Baseline hours were defined for each modification task as shown in the Hours/Task column. Then, the modification actions for each package were determined. The number shown for a given modification-type represents the number of times that different engineering activities are required for the same type of modification. If, for example, more than one circuit board in a package required a conformal coating but the boards are similar, the number used for engineering estimates could be reduced. The total hours for each task were determined to indicate areas where tradeoff of relaxed specification requirements might be justified as an approach to reducing modification costs.

SELECTED UNITS 34

MODIFICATION OR PROCESS TASKS	HOURS/TASK	DATATRON TIMER	TENNELEC TIMER	RESEARCH DISPLAY TERM.	FLUKE MIL. DVM	TOTAL (HOURS)
MODIFICATION ANALYSIS		60	60	100	20	2600
SECURE PRINTED CIRCUIT BD	40		1	3	1	1440
150-HOUR BAKEOUT	10	X	X	X		300
SECURE FASTENERS	6	X	X	X	X	168
CONFORMALLY COAT PRINTED CIRCUIT BOARD	20/BD	2	1	3		2240
PROVIDE PROTRUSION PROTECTION	40	X	X			1280
SECURE CANTILEVERED COMPONENTS	80	1	1	2		880
REPLACE KNOBS & BUTTONS	2/KNOB	7	6	30	9	385
CLIP CAPACITORS	40	2	1			600
EPOXY HEAT SINKS	4		X		X	20

71 TASKS

TENNELEC TIMER	HOURS
ENGINEERING	312
TEST PROCEDURES	40
TOTAL	352

Figure 3-30. Engineering Cost Estimate (Modified Equipment)

The engineering estimates for the Tennelec timer are shown. It is estimated that 60 hours would be consumed analyzing and inspecting the equipment to determine the modification required to make the equipment suitable for the Spacelab. The circuit boards in the scaler amplifier and the timer modules are very similar in mounting and configuration, indicating that engineering for both would be about the same. Therefore, only 40 hours were spent to define a rugged circuit board installation, and 20 hours were spent to assure that the conformal coating would have no adverse effect on the circuit board component. Ten hours were spent to define the bakeout procedure used to volatize contaminants possibly present in the package. Only 6 hours were spent changing the structural fasteners to a locked type that will not shake loose in vibration; 40 hours were spent defining guards for protrusions on the package; 80 hours were spent to define a mounting reinforcement for a cantilevered trimpot on the amplifier module which could come loose in vibration. Six knobs were replaced because they were made of plastic. Since it is estimated that approximately two hours are required to define a source for new knobs of the proper configuration, a total of 12 engineering hours were estimated for this activity. Forty hours are required to provide support for two lead-mounted capacitors in the power supply.

Engineering hours directly related to the modification and process activities defined for the Tennelec unit totaled 312 hours. Preparation of the verification test procedure required an additional 40 hours, bringing the total hours for engineering to 352 hours. The engineering cost was then determined by multiplying these hours by an average engineering labor rate.

Fabrication. Beckman Instruments performed the fabrication and associated manufacturing cost estimates for all modifications. The manufacturing engineering department utilized standard data, wherever possible, based on historic information from instruments presently being manufactured. Consideration was given to the selection of fabrication methods and assembly techniques which were most appropriate and least costly for single-unit production to accommodate proper work planning and the setup time involved.

Manufacturing engineering performed a detailed review of each modification on an operation-by-operation basis, including disassembly and reassembly, where required. Estimates were generated for any and all fabrication, tooling, test, inspection and material costs involved. Hourly estimates for labor were prepared, extended by appropriate direct labor rates, burden and administrative expense and summed to a total. The same approach was used to develop the material cost associated with the modification. A separate work sheet was generated for each piece of equipment selected in the modification program.

A typical worksheet used to estimate manufacturing costs is shown in Table 3-5. Beckman Instruments performed this activity to assure that manufacturing hour estimates conform to experience in the instrumentation industry.

Table 3-5. Manufacturing Cost Estimate (Modified Equipment)

ASSEMBLY NO. Tennelec TC545A ASSEMBLY NAME Counter Assembly NEXT ASSY NO. ___ DATE 5/ 1 / 74

ITEM	PART NO.	PART DESCRIPTION	QTY	LABOR HOURS FAB	ASS'Y	INSP.	TEST	MFG E	MFG TECH		COST $ MAT'L	LABOR	TOTAL
I	A	Protrusion protection	2	2.00		.20					10.00		
	B	Fab. and install PCB stiffeners	1	1.50	.50	.20					7.50		
	C	Secure trimpot	1	1.00		.10					3.80		
	D	Secure capacitors	2	.40	1.00	.40					1.20		
	E	Epoxy on heat sinks	2		.10	.10					.30		
	F	Replace knobs	8		1.50	.60					12.00		
	G	Replace fasteners	30		1.00	.50		1.00			2.00		
	H	Conformally coat PCB	1		1.00	1.00		1.00	.50		2.00		
II	A	150-hour bakeout					10.00	10.00			350.00		
	B	Test and calibration					5.00		5.00				
		TOTAL		4.90	5.10	3.10	15.00	12.00	5.50		388.80	656.96	1045.76

Hours for each type of manufacturing activity are identified for all modifications. Manufacturing activities included fabrication, assembly, inspection and test activities and also include additional hours for a manufacturing engineer and a manufacturing technician support.

The Cost columns show the material costs associated with each modification activity and the extension of the labor hours into dollars. The sum of the activity costs leads to a total manufacturing cost of $1045.76 for the Tennelec modules.

Individual costs are self-explanatory except the $350 for the 150-hour bakeout. This process is assumed to be performed by an outside vendor and shows as a material cost. Labor hours identified support this testing activity.

Test. The cost of development testing was estimated by engineering in conjunction with test laboratory personnel. Consideration was given to the type of environment to which the equipment would be subjected as well as its basic functional requirement. Each piece of equipment was reviewed individually for such testing as shock, mechanical vibration, accoustical vibration, EMI generation, and off-gassing. Estimates were generated based upon the complexity of the unit and the amount of modification required.

Documentation. Documentation costs were estimated by factoring off the total of fabrication, engineering and test costs and proportioning this cost equally among all equipment items. The documentation effort represents the fixed programmatic documentation effort. Its cost does not vary with equipment costs. The factor used to develop the documentation estimate was based upon prior historic cost data from other in-house programs. An example of the formula as used is as follows:

Total Manufacturing/Engineering/Test	$669,000
Documentation Factor	10 percent

$669,00 x .10 = $66,900

$$\frac{\$66,900}{31} = \$2153 \text{ (rounded to \$2160) cost to each unit}$$

Program Management. The program management effort was also estimated by a factor developed from prior in-house cost experience. The factor was applied to total cost on the theory that management will pay more attention to costly items because (1) their cost reflects the number and complexity of the modification actions, and (2) a greater financial risk is incurred with the higher cost items. Tabulated below is the formula used to cost program management effort:

Selected Unit - Tennelec Timer

Total Manufacturing/Engineering/Test/Data Management	$12,158
Program Management Factor	5 percent

$12,158 x .05 = $607

The hour estimates generated for engineering and test effort were extended by appropriate rates which included labor, burden and administrative expense for the 1974 time frame. Any material required, such as test fixtures, was costed in total by adding procurement and administrative expenses to the basic estimate. The total cost of each modified off-the-shelf unit was determined by adding the retail cost to the cost of modification. Total modified hardware costs are reported in Volume III in the same manner as shown for the Tennelec Timer in Table 3-6.

Table 3-6. Modified Tennelec Timer Costs

Manufacturing	$ 1,129
Engineering	4,453
Test	4,516
Documentation	2,160
Program Management	607
Total Modification	12,765
Basic Cost	1,500
Total Cost	$14,265

3.4.1.2 Custom-Built Equipment

Parametric pricing techniques were employed to cost the new development hardware. This involved a comparison of technical characteristics and cost of the new hardware to that of existing or previously defined equipment where similar history was available. Cost projections were accomplished by the use of cost estimating relationships (CER's), knowledge of the technical characteristics of both programs, state-of-the-art position of the hardware, and a complexity analysis.

A list containing the hardware identified as representative equipment was compiled and reviewed to determine its similarity to a known piece of equipment or system. System in this sense pertains to a group of items or an assembly within which the equipment under consideration would be an integral part. A matchup was made to information contained in the data bank with regard to weight, technical characteristics and function. In some cases, it was more prudent to select multiple-source data in order to establish the more reliable hardware.

Once the source data were identified, a more in-depth review was made to establish a complexity relationship. While this complexity analysis can become subjective, the technical information contained in the data bank (if properly utilized) aids the engineer in preparation of a more objective result. To assess the complexity required in this study, the cognizant engineer was given the opportunity to apply his knowledge to an in-depth technical data source. This enabled the engineer to realistically ascertain the relative complexity of the hardware under consideration as compared to the previously built and/or designed equipment. The complexity multiplier reflects the relation of the design complexity of the selected hardware item to the design complexity of the benchmark unit used for the CER basis. In some cases the relative weight of the selected and benchmark units also reflect complexity, requiring the engineer to normalize his estimate on a complexity-per-pound basis. To finalize the CER used in this study, a state-of-the-art calculation was applied. The impact of this cost driver in regard to development cost is the state-of-the-art "know-how" status at the point in time of the new item of equipment versus that at the time of development of the benchmark unit.

The four numerical ratings as listed in MF003N[1] and an additional category called "off-the-shelf hardware" were used in making the state-of-the-art determination. They reflect the variation in degrees of definition from beyond the state of the art to off-the-shelf hardware. The designation graduations of 20 percent of the 5 categories, on a scale from 20 to 100, were applied to further adjust the CER used in the study for each individual equipment item selected. The state-of-the-art rationale and its percentage application are reflected in Table 3-7.

[1] Document, Program Study Cost Estimates, revised 1 March 1973, NASA-MSFC.

Table 3-7. State-Of-The-Art Rationale

Description	Percent
OFF THE SHELF. The equipment can be placed on board in an as-is configuration.	20
MINOR MODIFICATION. Equipment requiring packaging modifications but no functional design changes are necessary. Unit retains its basic configuration. Most electrical hardware falls into this category.	40
REDESIGN REQUIRED. New configuration is necessary to be suitable for space operations. Basic operating principle remains the same; includes straightforward solutions to replacement of gravity-dependent functions. (The Beckman spectrophotometer is a unit requiring ruggedizing as well as sample containment in zero g.) The latter problem can be solved by evacuated sample containers and syringe sample injection.	60
SLIGHTLY BEYOND STATE OF THE ART. New configuration is necessary with improvements in functional capability requiring development. Zero-g operation requires new approach. Laboratory prototypes may exist. For example, a working prototype of the Coulter blood cell counter has been developed by Beckman for NASA.	80
SUBSTANTIALLY BEYOND STATE OF THE ART. Designs meeting requirements have not yet advanced beyond conceptual level. As an example, approaches for two-phase fluid containment for a zero-g cryogenic dewar have only been hpothesized on paper. Electrophoretic retention of the liquid phase material is one such suggested approach.	100

Figure 3-31 illustrates the process by which the custom cost of an item was determined. The Tennelec Timer is again used as an example. Design development, test and engineering (DDT&E) costs are coupled with the cost to manufacture the first unit to arrive at a total first article cost. The elements of the cost analysis were determined as follows.

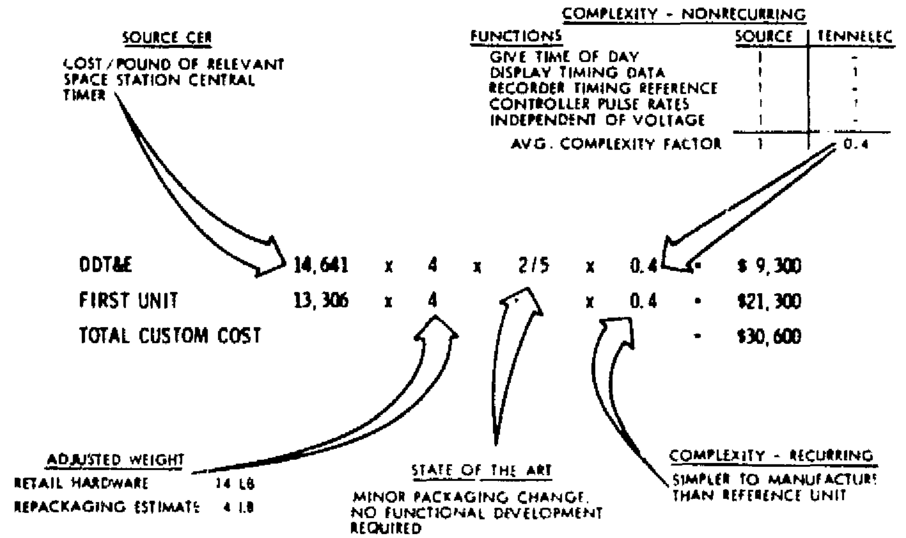


Figure 3-31. Sample Custom Cost Estimate (Tennelec Counter/Timer)

1. The Space Station central timing package was selected as the most relevant hardware item for which cost data existed in the data bank. The cost per pound for DDT&E and the first unit of this package are 14,641 and 13,306 dollars per pound.

2. The estimated weight of the custom-built item was then determined by evaluating how much of the unit could be reconfigured into the more compact-type packaging used in the aerospace industry. The commercial modular assembly weighs 14 pounds. Engineering estimated that the weight could be reduced to 4 pounds. The existing unit has considerable structural weight that can be eliminated. Also, much of the power conditioning can be eliminated. These modules normally use ± 12 volts or ± 24 volts dc, which can easily be obtained from the 28 volts dc on-board power supply, thereby eliminating the integral power conditioning currently required to change 110 volts ac to ± 12 volts and ± 24 volts dc.

3. Since minor packaging changes are required to make the unit consistent with aerospace packaging design practices, a 2/5 factor was assigned to the state-of-the-art multiplier. Since the CER used was for hardware at a conceptual level, a multiplier of 1 would have been used if the development status of the subject timer would also be conceptual. If the subject timer were in the prototype stage, a 4/5 multiplier would have been used. If major modifications were required (such as development of a gravity-insensitive function), a 3/5 multipler would have been used. Off-the-shelf hardware would have a multiplier of 1/5.

4. Complexity is broken down into two types. Nonrecurring complexity represents the relative functional complexity of the reference and selected item. The figure compares functional capabilities of the source and sample hardware elements. The Tennelec unit can only accomplish two of five functions accomplished by the reference unit, leading to a complexity multiplier of 0.4. The recurring cost complexity factor is also 0.4, reflecting the simpler construction and assembly required by this less complex package.

The custom cost then is determined by multiplying the above factors together. The accuracy of these estimates is verified by comparing the values to those derived on other studies and vendor estimates. Such a comparison exists for the Fluke frequency synthesizer. Fluke personnel indicated that their Mil-Spec unit cost approximately $500K to develop. The analytical approach used in the study estimated the cost for a new frequency synthesizer to be $452K, indicating good correlation.

3.4.2 Modification Cost Summary

The results of the detailed cost estimates for each of the modified selected hardware items is presented in this section. Table 3-8 identifies the modification cost of each item by its work breakdown structure category, and totals the costs incurred for the selected items in each category.

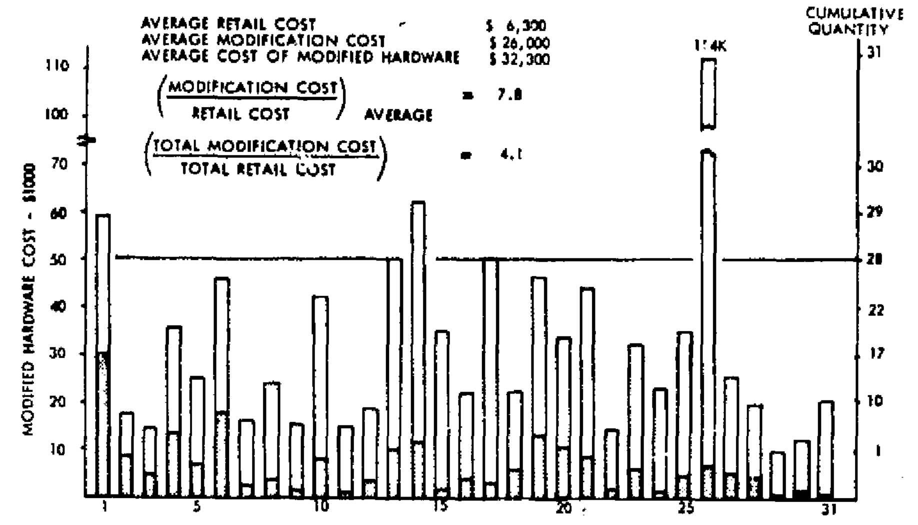
Table 3-8. Modified Equipment Cost

Selected Equipment	Mfg.	Eng.	Test	Doc.	Program Mgmt.	Total
Tape Recorder						
Ampex	6,034	8,979	4,416	2,160	1,616	23,205
Honeywell	14,620	15,548	4,416	2,160	1,616	38,360
Computer	20,907	17,333	5,888	2,160	2,228	48,516
Keyboard Display	4,979	19,136	5,888	2,160	1,565	33,728
Timer						
Datatron	3,029	7,452	4,416	2,160	844	17,901
Tennelec	1,129	4,453	4,416	2,160	607	12,765
Spectrophotometer	17,135	17,885	8,832	2,160	2,239	48,251
EMI-Intens. Meter	3,367	11,261	4,416	2,160	1,064	22,268
Transmitter						
RHG	835	2,392	2,944	2,160	417	8,748
Collins	1,302	3,128	2,944	2,160	477	10,011
Signal Conditioner	3,611	6,100	2,944	2,160	741	15,556
Spec. Wave Analyzer						
Hewlett-Packard	7,891	17,056	4,416	2,160	1,576	23,099
Singer	3,040	11,684	4,416	2,160	1,065	22,365
Fluke	2,941	7,250	4,416	2,160	838	17,605
Nuclear Data	5,665	15,070	4,416	2,160	1,366	28,677
Laser Assembly	4,801	10,488	4,964	2,160	1,121	23,534
Gas Chromatograph	8,163	17,811	5,988	2,160	1,661	35,783
Microscope	1,330	6,090	2,208	2,160	589	12,377
Strip Chart Recorder	6,882	11,297	4,416	2,160	995	25,750
Volt-Ohm Meter						
8200	4,652	12,935	2,944	2,160	1,056	23,747
8125	1,535	5,778	2,944	2,160	621	13,038
Oscilloscope						
Tektronix	9,352	13,119	4,416	2,160	1,328	30,375
Hewlett-Packard	8,640	7,139	2,944	2,160	965	21,848
Electrophoresis	14,280	49,000	35,872	2,160	5,016	106,328
Furnace	1,216	11,206	4,416	2,160	950	19,948
Power Supply						
Power Design	1,728	6,109	4,416	2,160	680	15,093
Sorenson	1,996	7,360	2,944	2,160	723	15,183
Centrifuge	1,014	3,956	1,472	2,160	391	8,993
Particle Counter	2,259	7,250	2,944	2,160	745	15,358
Microtome	1,751	3,662	2,208	2,160	476	10,257
pH Meter	2,197	9,586	5,888	2,160	946	20,777
Total	168,281	347,513	160,168	66,960	36,522	779,444

The equipment selected for review is grouped by category of equipment, so that where more than one of a similar item has been analyzed, a rapid comparison can be made of the difference in modification cost. The higher the cost, in a comparison of this nature, the less flightworthy the item was in its original configuration. As an example, the Tennelec timer required approximately two-thirds the modification of the Datatron timer because its basic design was more vibration-proof than was the Datatron model. Each of the differences, accounting for the cost variations, is discussed in depth in Section 2.0, Volume III.

Figure 3-32 shows the distribution of costs of modified available hardware. Darkened portions of each bar represent the retail cost for each unit, while the open part of the bar reflects the estimated cost of modification. Estimated modified hardware cost can be read from the left-hand ordinate. The cumulative quantity of modified hardware costs, below given cost plateaus, is shown on the right-hand ordinate. For example, 28 of 31 items can be purchased and modified for less than $50,000

Statistical information is presented in the center of the figure. The average retail, modification, and modified hardware costs apply to the 31 items analyzed. The average of modification cost, divided by retail cost, was determined by calculating this ratio for each item and finding the mean of these values. This value is different from the ratio of total modification and retail costs. It was determined from the ratio of the sums of both costs. Care must be used applying these ratios to other groups of hardware. The average of all cost ratios tends to emphasize ratios for items with low retail costs. The ratio of total costs tends to emphasize the high-cost items. Together, they provide an indication of the range of values expected for modification activities.



EQUIPMENT IDENTIFICATION KEY

UNIT NO.		UNIT NO.	
		16	TIMER - DATATRON
1	TAPE RECORDER - AMPEX	17	SPECTROPHOTOMETER - BECKMAN
2	TRANSMITTER - RHG	18	AMPLIFIER - NEFF
3	TRANSCEIVER - COLLINS	19	SPECTRUM ANALYZER - HEWLETT-PACKARD
4	EMI FIELD INTENSITY METER - SINGER	20	LASER - SYLVANIA
5	WAVE ANALYZER - SINGER	21	GAS CHROMATOGRAPH - BECKMAN
6	FREQUENCY SYNTHESIZER - FLUKE	22	MICROSCOPE - AMERICAN OPTICAL
7	VOLT/OHM METER - FLUKE #8125	23	STRIP CHART RECORDER - HONEYWELL
8	OSCILLOSCOPE - HEWLETT-PACKARD	24	VOLT/OHM METER - FLUKE #8200
9	TIMER/COUNTER - TENNELEC	25	OSCILLOSCOPE - TEKTRONIX
10	MULTICHANNEL ANALYZER - NUCLEAR DATA	26	ELECTROPHORESIS ASSY - BECKMAN
11	POWER SUPPLY - POWER DESIGNS	27	FURNACE - ASTRO
12	PARTICLE COUNTER - ORTEC	28	POWER SUPPLY - SORENSON
13	TAPE RECORDER - HONEYWELL	29	CENTRIFUGE - CLAY ADAMS
14	COMPUTER - DIGITAL EQUIPMENT	30	MICROTOME - AMERICAN OPTICAL
15	KEYBOARD DISPLAY TERMINAL - RESEARCH INC.	31	pH METER - BECKMAN

Figure 3-32. Modification Versus Retail Cost

Equipment analyzed was divided into four classes--airborne, Mil-Spec, NIM, and commercial. Figure 3-33 indicates the relative cost to modify different types of equipment. All data shown reflect the same trend. Modification costs are the least for airborne equipment. They are somewhat higher for Mil-Spec equipment, still higher for NIM equipment, and highest for commercial hardware. These data are consistent with the general impressions developed during the suitability analysis.

SPECIFICATION	$\left(\frac{\text{MODIFICATION}}{\text{RETAIL}}\right)_{AV}$	$\left(\frac{\text{TOTAL MOD.}}{\text{TOTAL RETAIL}}\right)$
AIRBORNE	1.4	1.2
MIL-SPEC	3.6	2.2
NIM	6.3	4.9
COMMERCIAL	10.0	5.6

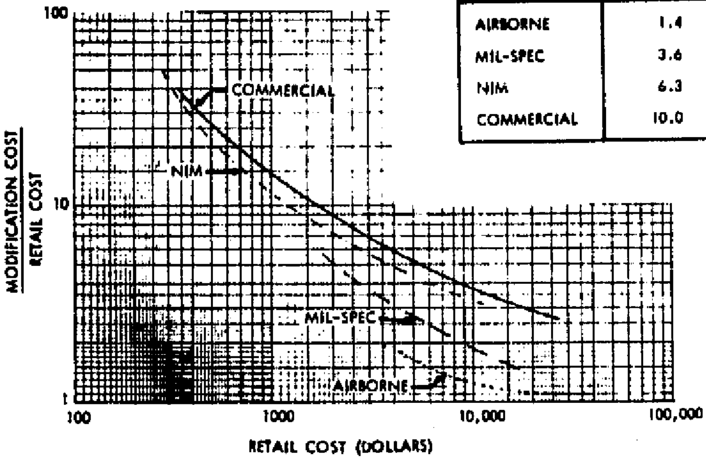


Figure 3-33. Design Specification Impact on Modification Costs

A curve plot of the data is shown along with modification cost ratios previously used. The curves represent the best fit to the data which vary over broader bands than indicated by the thin lines.

Airborne equipment has the lowest modification costs because they tend to have rugged construction, are sealed preventing atmosphere interchange, and operate at altitudes up to 55,000 feet (16.5 km), requiring minimum reliance on convection for cooling. Some Mil-Spec units display similar characteristics such as the Fluke Mil-Spec voltmeter built for submarine installation, however, others meet military specifications not as important to Spacelab installation. For example, the Hewlett-Packard military oscilloscope is built for field use so it is protected from all types of hostile environments. It still has the same vibration inadequacies as its commercial counterpart. NIM units show several good characteristics such as approved material usage and a design compatible with forced-air ventilation. However, these units have poor vibration characteristics. Volumetric efficiency is also very poor with these items.

The curve displays a common characteristic among all design types. As the retail cost decreases, the ratios increase. This effect is a result of certain types of modifications or processes being common with all units such as a trace contaminant bakeout or some ruggedizing for vibration. Also, certain fixed costs such as documentation and engineering to determine the need for modification cause the modification cost to diminish more slowly than the retail cost. As a result, all ratios are higher at lower retail costs.

C.2

The major cost driver to equipment modification was the lack of a gravitational field in space. The three units which could not be modified depended on gravity to function. Two of these units, the refrigerator and dewar, require completely new design approaches to operate in zero gravity. The third unit had additional inadequacies for operation in the Spacelab. The Coulter counter uses gravity as the motivating force for sample flow. A falling mercury column reduces the pressure behind an orifice causing the sample to flow through the orifice It also had little structural strength and used glass throughout. The refrigerator and the dewar employ gravity to separate gas and liquid fluid phases. Such separation maintains liquid in the evaporator and allows only gas to enter the compressor of the refrigerator. The same separation keeps liquid in the dewar and allows only gas to escape the vent located at the top of the dewar. Totally new developments are required in all three cases.

Modifications were identified for the units having gravity-dependent functions (see Figure 3-34). Modifications vary from development of a new batch-type electrophoresis cell to adding a few retaining screws to the turrets of a microscope. The retail and modification costs as well as the ratio of modification and retail costs are shown on the figure to indicate the range of values determined during the study.

SELECTED ANALYZED UNITS	COST ($1000)		$\left(\frac{\text{MODIFICATION}}{\text{RETAIL}}\right)$
	RETAIL	MODIFICATION	
SPECTROPHOTOMETER	2.7	47.0	17.5
ELECTROPHORESIS	6.8	113.0	16.7
pH METER	0.6	20.0	33.4
MICROSCOPE	1.6	12.4	7.9
CENTRIFUGE	0.3	8.2	25.3

• SUMMARY OF ALL EQUIPMENT

	GRAVITY DEPENDENT	GRAVITY INDEPENDENT
$\left(\frac{\text{MODIFICATION COST}}{\text{RETAIL COST}}\right)_{AV}$	20	5.4
$\left(\frac{\text{TOTAL MODIFICATION COST}}{\text{TOTAL RETAIL COST}}\right)$	20.1	3.1

Figure 3-34. Gravity Dependence Impact on Modification Costs

When the tabular data are expanded to include all the units analyzed, the cost impact is quite clear. Either ratio shows a 20-to-1 cost multiple for gravity-dependent units, indicating good correlation over all retail price ranges. When this value is compared to the same ratio for units which operate independent of gravity, it is clear that equipment dependent upon gravity incur significantly higher modification costs than those that are independent.

The impact of the basic operating principle on modification costs was assessed. Figure 3-35 shows that chemical analysis hardware is the most costly to modify. It also indicates that mechanical and electrical hardware is the least costly.

Different conclusions can be drawn from the ratio data, depending upon which ratio is used for the electrical, mechanical and optical equipment. Therefore, conclusions are deferred to more in-depth study. The conclusion is clear, however, for the chemical analysis hardware. It is the most costly to modify.

	ELECTRICAL	MECHANICAL	OPTICAL	CHEMICAL
$\left(\frac{\text{MODIFICATION COST}}{\text{RETAIL COST}}\right)_{AV}$	7.0	8.4	9.0	18.0
$\left(\frac{\text{TOTAL MODIFICATION COST}}{\text{TOTAL RETAIL COST}}\right)$	3.0	2.3	5.8	11.5

• CUSTOM-BUILT HARDWARE, EITHER CHEMICAL ANALYSIS INSTRUMENTATION OR SUPPORT EQUIPMENT

CHEMICAL ANALYSIS HARDWARE	COST ($1000) RETAIL	MODIFICATION	$\left(\frac{\text{MODIFICATION}}{\text{RETAIL}}\right)$
SPECTROPHOTOMETER	2.7	47.0	17.0
GAS CHROMATOGRAPH	8.0	35.0	4.4
ELECTROPHORESIS APPARATUS	6.8	105.0	15.5
pH METER	0.6	20.0	34.8

Figure 3-35. Operating Principle Impact on Modification Costs

The high cost of modification is, for the most part, due to reliance upon gravity for many functions and construction suited only to the benign environment of the laboratory. The gas chromatograph, an exception, demonstrates that chemical analysis hardware, operating independent of gravity and of more rugged construction, can have a low modification cost ratio more typical of electrical hardware.

The dewar, refrigerator, and Coulter counter amplify the high-cost conclusion regarding chemical analysis hardware. The Coulter counter is a chemical analysis instrument. The dewar and refrigerator, in general, support chemical or biological analysis activities. None of these three could be used in a modified form.

3.4.3 Cost of Custom Equipment Summary

The custom, or new development hardware cost, has been summarized in Table 3-9. An explanation of the columnar headings is given below.

Weight. The projected weight of the equipment with the modifications taken into account.

CER. The cost estimation relationship, reflected in dollars per pound after consideration was given to weight scaling, complexity and state-of-the-art of the base CER.

Complexity Factor. The complexity of engineering, fabrication and test of the item as related to the benchmark equipment from which the CER was derived.

State-Of-The-Art. The numerical designation, as discussed in Section 3.4.1, reflects the relative state-of-the-art of the new item when compared to the benchmark hardware. The number designation is converted to a percentage for formula use.

Source Data. The source of the applicable CER for each unit is presented in this column.

Table 3-9. New Hardware Development Cost

SELECTED EQUIPMENT	WEIGHT LB	WEIGHT (KG)	CER $/LB	COST MILLION $	COMPLEXITY	STATE OF THE ART	SOURCE DATA
TAPE RECORDER - AMPEX	80	(36.3)	2,500	0.200	0.7	1	AMPEX QUOTE
- HONEYWELL	80	(36.3)	2,500	0.200	0.7	1	AMPEX QUOTE
COMPUTER	119	(54.0)	1,782	0.212	1.0	2	SHUTTLE ORBITER
KEYBOARD DISPLAY TERMINAL	30	(13.6)	16,767	0.503	1.0	2	ORBITER AVIONICS
BLOOD CELL COUNTER	15	(6.8)	27,800	0.417	2.0	4	BECKMAN - BCC
TIMER - DATATRON	9	(4.1)	19,222	0.173	1.0	2	ORBITER - TIMING UNIT
- TENNELEC	4	(1.8)	7,750	0.031	0.4	2	
SPECTROPHOTOMETER	30	(13.6)	16,867	0.506	1.0	3	UV GRATING SPECTROMETER
EMI FIELD INTENSITY METER	25	(11.3)	7,480	0.187	1.0	2	LUNAR ORB STUDY, RADIO NOISE
TRANSMITTER - RHG	20	(9.1)	12,900	0.258	1.0	2	SHUTTLE ORBITER - COMMUNICA.
TRANSCEIVER - COLLINS	17	(7.7)	12,900	0.219	1.0	2	SHUTTLE ORBITER - COMMUNICA.
AMPLIFIER - NEFF	16	(7.3)	3,188	0.051	0.7	2	SHUTTLE ORBITER - AVIONICS
SPECTRUM ANALYZER - HEWLETT-PACKARD	40	(18.2)	12,900	0.516	1.0	2	SHUTTLE ORBITER - COMMUNICA.
- SINGER	35	(15.9)	12,914	0.452	1.0	2	SHUTTLE ORBITER - COMMUNICA.
FREQUENCY SYNTHESIZER - FLUKE	35	(15.9)	12,914	0.452	1.0	2	SHUTTLE ORBITER - COMMUNICA.
MULTICHANNEL ANALYZER - NUCLEAR	45	(20.4)	12,911	0.581	1.0	2	SHUTTLE ORBITER - COMMUNICA.
LASER	30	(13.6)	5,700	0.171	1.0	2	LASER ALT. - LUNAR ORB STUDY
GAS CHROMATOGRAPH	30	(13.6)	13,333	0.400	1.0	2	CSM - ECS
MICROSCOPE	20	(9.1)	1,800	0.036	1.0	2	SPACE STA EXP 5.13-SE
STRIP CHART RECORDER	25	(11.3)	14,520	0.363	1.0	2	CSM - DISPLAY & CONTROLS
VOLT/OHM METER - 8200	10	(4.5)	4,000	0.040	1.0	2	SPACE STA EXP 5.22-SE
- 8125A	10	(4.5)	4,000	0.040	1.0	2	
OSCILLOSCOPE - TEKTRONIX	20	(9.1)	16,300	0.326	2.0	2	SHUTTLE ORBITER - COMMUNICA.
- HEWLETT-PACKARD	10	(4.5)	14,900	0.149	1.0	2	SHUTTLE ORBITER - COMMUNICA
ELECTROPHORESIS APPARATUS	30	(13.6)	6,200	0.186	1.5	4	SPACE STATION EXP 5.13
FURNACE	100	(45.4)	4,530	0.453	0.2	3	SPACE STATION EXP 5.16
DEWAR	5	(2.3)	262,000	1.310	1.0	5	BEECH CRYOGENIC TANKAGE
POWER SUPPLY - SORENSON	50	(22.6)	520	0.026	0.2	2	SHUTTLE ORBITER EPS
- POWER DESIGNS	10	(4.5)	2,400	0.024	0.3	2	SHUTTLE ORBITER EPS
CENTRIFUGE	25	(11.3)	960	0.024	0.2	3	SPACE STATION EXP 5.13C
REFRIGERATOR/FREEZER	50	(22.7)	2,540	0.127	1.0	4	SPACE STA EXP 5.13/5.16
PARTICLE COUNTER	6	(2.7)	34,833	0.209	0.4	2	LOW-ENERGY PARTICLES
MICROTOME	50	(22.7)	620	0.031	0.2	2	SPACE STATION EXP 5.13
pH METER	1.5	(0.7)	56,667	0.085	1.0	3	BECKMAN CSM - pH ANALYZER

3.4.4 Comparison of Modified Hardware Cost to Custom-Built Hardware Cost

This section summarizes and compares the cost of hardware being modified or custom built. It provides a visual overview at the total cost level and rapidly identifies the wide range of differences between the two concepts.

The costs in Table 3-10 are reflected in millions of dollars and the columnar headings are explained below.

Modification Cost. Total cost of item after modification, including basic or retail cost.

Development Cost. The cost of developing or custom building hardware for its specific purpose.

Delta. The net difference in cost between developing a new piece of hardware or modifying an off-the-shelf item.

Comparison of the custom costs generated to vendor information on development costs of like equipment shows good correlation. Vendor development information is shown below.

Fluke Spectrum Wave Analyzer

Present retail cost	$ 17,200
Original development cost	$500,000
Ratio	29:1

Ampex Tape Recorder

Present retail cost	$ 175,000
Development cost	$5,500,000
Ratio	31:1

Retail and development cost are based on data for Skylab tape recorder.

As a comparison to the above, the study reflects the following:

Average Custom Unit Cost

Total development cost	$225,000
Average retail cost	6,300
Ratio	36:1

It is concluded that the costing approach used is reasonable, and that the magnitude of the costs is representative of the costs of custom-built hardware. The slightly higher ratio of the study hardware results from the inclusion of some low-cost items which tend to have high retail-to-custom ratios.

Table 3-10. Comparison of Modification Cost to Custom-Built Cost

SELECTED EQUIPMENT	COST IN MILLION $		
	MODIFIED EQUIPMENT	CUSTOM EQUIPMENT	DELTA
TAPE RECORDER			
AMPEX	0.058	0.200	0.142
HONEYWELL	0.050	0.200	0.150
COMPUTER	0.062	0.212	0.150
KEYBOARD DISPLAY TERMINAL	0.035	0.503	0.468
BLOOD CELL COUNTER	--	0.417	0.417
TIMER			
DATATRON	0.021	0.173	0.152
TENNELEC	0.014	0.031	0.017
SPECTROPHOTOMETER	0.050	0.506	0.456
EMI FIELD INTENSITY METER	0.038	0.187	0.149
TRANSMITTER - RHG	0.018	0.258	0.240
TRANSCEIVER - COLLINS	0.015	0.219	0.204
AMPLIFIER - NEFF	0.028	0.051	0.028
MULTICHANNEL ANALYZER - NUCLEAR	0.043	0.581	0.538
SPECTRUM ANALYZER - HEWLETT-PACKARD	0.048	0.516	0.468
WAVE ANALYZER - SINGER	0.030	0.452	0.422
FREQUENCY SYNTHESIZER - FLUKE	0.037	0.452	0.415
LASER ASSEMBLY	0.035	0.171	0.136
GAS CHROMATOGRAPH	0.045	0.400	0.355
MICROSCOPE	0.014	0.036	0.022
STRIP CHART RECORDER	0.033	0.363	0.330
VOLT/OHM METER			
8200	0.025	0.040	0.015
8125A	0.015	0.040	0.025
OSCILLOSCOPE			
TEKTRONIX	0.035	0.326	0.295
HEWLETT-PACKARD	0.025	0.149	0.124
ELECTROPHORESIS APPARATUS	0.114	0.18[illegible]	0.072
FURNACE	0.026	0.45[illegible]	0.427
DEWAR	--	1.310	1.310
POWER SUPPLY			
SORENSEN	0.020	0.026	0.006
POWER DESIGNS	0.015	0.024	0.009
CENTRIFUGE	0.009	0.024	0.015
REFRIGERATOR/FREEZER	--	0.127	0.127
PARTICLE COUNTER	0.019	0.209	0.190
MICROTOME	0.012	0.031	0.019
pH METER	0.021	0.085	0.064
TOTAL	1.005	8.958	7.953

The bar chart shown in Figure 3-36 illustrates the distribution of custom-built and modified hardware costs. Refer to Figure 3-32 for the equipment identification key. The darkened portion of each bar represents the cost of modifying available hardware. Cost magnitudes can be read from the left-hand ordinate, while the cumulative quantity of items costing less than a given cost plateau can be determined from the right-hand ordinates. For example, 22 of 34 items cost less than $300,000 to develop.

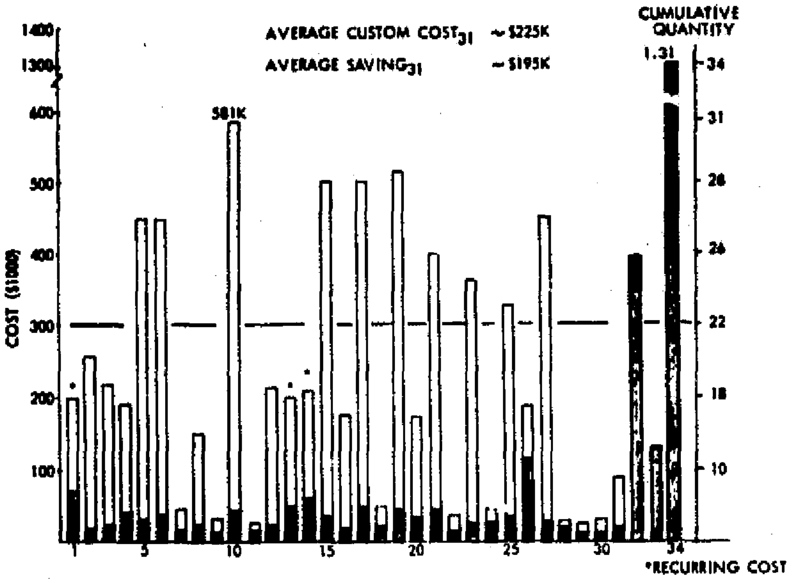


Figure 3-36. Modified Versus Custom Cost

Large savings are evident for many of the selected items. Savings could be achieved for all but 3 of the 34 selected items. Custom costs averaged approximately $225,000 of which $195,000 could be saved on the average if available equipment were modified rather than custom building the same hardware. These average savings may be understated since new hardware was not built for three units--two tape recorders and one computer. An asterisk appears above each unit. The tape recorder used on the Skylab could be made available, built to NASA specifications, for $175K (according to an Ampex quote). Therefore, rather than building a new recorder, the price of this unit was used. The computer price is based on a preliminary quote for a unit planned for use in space.

The three units which could not be cost effectively modified are the Coulter blood cell counter, the REVCO refrigerator freezer, and the Cryogenic Associates dewar (numbers 32 through 34).

Figure 3-37 shows the results of an analysis of the cost effectiveness of modified electronic instrumentation. As a group, it presents the greatest opportunity for savings to the Spacelab program.

Data from several of the units analyzed are shown on this chart. All the units show significant savings. These savings could be expected since their

operation is independent of gravity, they are built for rack-mounting and, in general, for forced-air cooling. Modifications were limited to minor repackaging without requiring any significant developments. The summary modification ratio data indicate good correlation with either ratio.

SELECTED ANALYZED UNITS	COST ($1000) RETAIL	MODIFIED	CUSTOM	(CUSTOM / MODIFIED)
EMI FIELD INTENSITY METER	13.5	38.0	187.0	4.9
SPECTRUM WAVE ANALYZER	12.9	48.0	516.0	10.8
STRIP CHART RECORDER	6.0	28.0	363.0	13.0
OSCILLOSCOPE	4.2	33.0	326.0	10.0
PARTICLE COUNTER	3.0	19.0	209.0	11.0

SUMMARY OF ALL EQUIPMENT

	ELECTRONIC INSTRUMENTATION	OTHER
$\left(\frac{\text{CUSTOM BUILT}}{\text{MODIFIED}}\right)_{AV}$	10.1	5.7
$\left(\frac{\text{TOTAL CUSTOM COST}}{\text{TOTAL MODIFIED COST}}\right)$	10.6	6.0

Figure 3-37. Electronic Instrumentation Most Cost Effective to Modify

3.5 SELECTED EQUIPMENT ANALYSIS CONCLUSIONS

The analysis of the 34 selected equipment items generated the following conclusions. Modifications required to make the equipment suitable for operation in space were not extensive. Vibration integrity and use of allowable materials were a common modification cause. The simple modifications recommended to make these equipment items suitable for operation in the Spacelab increased the cost of the equipment from 4 to 8 times. These costs are considerably less than the same equipment custom built. Custom building this already developed hardware cost an average of 36 times more than the retail hardware.

4.0 SPECIFICATION ANALYSIS

4.1 INTRODUCTION

NASA equipment specifications are being developed consistent with the practice on previous manned spacecraft programs such as Apollo and Skylab. These specifications tend to be rigorous and preclude the use of commercially available equipment. This section presents an analysis of the impact of a typical NASA-developed specification on the selected equipment, and examines several alternative requirements which might reduce the cost impact of these specifications.

Section 4.2 presents the comparison of the NASA-developed ground equipment specification, EC006M00000A - "Part I - Performance, Design and Verification Requirements for Experiment and General Laboratory Equipment to be Selected for Project Sortie Lab," with the interface document developed during this study. (These specifications are presented in Appendixes D and E of this volume.) Considerable equipment modification is required by the NASA specification in addition to those required by the SEEIR. Additional engineering activities are also generated by this more rigorous specification. Delta costs for these additional modifications to the selected modified hardware items are presented to quantify the impact of the NASA specification in dollars.

Section 4.3 presents the results of tradeoffs of alternative approaches to reducing equipment costs. Three tradeoffs of alternative requirements for the equipment specification are discussed. An analysis was performed to determine if improved vibration isolation of the equipment would reduce the available hardware modifications necessary to survive the boost vibration environment. Reduction of material control constraints is the issue evaluated in the second tradeoff. Alternatives to degradation-type requirements such as fungus and corrosion are addressed in a third tradeoff. A fourth tradeoff, unrelated to equipment specifications, was also accomplished. This analysis addresses the possibility of reducing the power demand of available equipment by redesigning the power supplies internal to the unit and, instead, using Spacelab-conditioned power directly in each unit.

4.2 NASA SPECIFICATION VERSUS INTERFACE SPECIFICATION

The cost delta of imposing the preliminary NASA Specification EC006M00000A over the minimum requirement approach of SEEIR was determined. The result indicates EC006M and/or the SEEIR changes that might lead to better overall cost effectiveness in equipment modification. The two specifications are broadly compared in Table 4-1 in order to provide insight into the origin and philosophy used in the development of these documents. In all cases, the EC006M specification requirements are equal to or in excess of the SEEIR. The SEEIR is intended as a minimum requirement baseline and has not been approved for use outside of this study.

Table 4-1. NASA and Study Specification Origins

	SPACELAB/EXPERIMENT EQUIPMENT INTERFACE REQUIREMENTS	EC006M00000A GENERAL EQUIPMENT SPEC. FOR EXPERIMENT EQUIPMENT
GENERATION		
BY:	ROCKWELL	NASA
FOR:	THIS STUDY	MANNED SORTIE MISSIONS
WHEN:	4-74	11-72 (PRELIMINARY)
PHILOSOPHY	• MAXIMIZE EXPERIMENTOR RESPONSIBILITY • MAXIMIZE COMMERCIAL EQUIPMENT POTENTIAL • OPERATIONAL SPACELAB ENVIRONMENT, NOMINAL GROUND ENVIRONMENT	• ASSURE EXPERIMENTER SUCCESS • COMPATIBLE WITH SPACELAB SUBSYSTEM REQUIREMENTS • SURVIVE VACUUM, WORST CASE TRANSPORTATION AND GROUND ENVIRONMENT

Figure 4-1 illustrates the logic process in determining the differences between the EC specification and the SEEIR. Initially the EC specification was evaluated to separate those requirements which were written as firm (uses the verb "shall"), and those that were not firm but advisory in nature ("shall consider", "should"). The objective of this activity is to reduce the probability of over-enforcing the NASA specification. For example, paragraph 3.2.6.2 of the EC specification states that "The equipment shall contain no ordnance devices," which is interpreted to mean that any item with ordnance devices (squib valves, etc.) would have to be replaced with alternate parts or designs. Another example is in paragraph 3.2.4.3 which states, "Accessibility

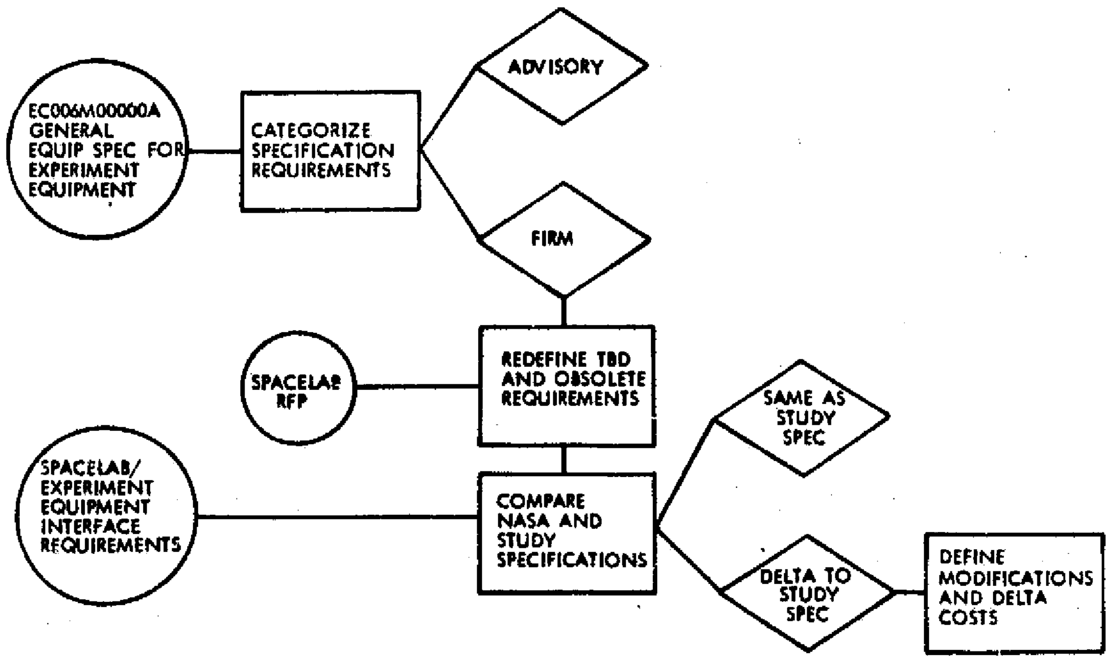


Figure 4-1. Specification Comparison - Approach

and ease of operation of latches, lockdowns, fasteners, etc., shall be considered for ease of maintenance." This is interpreted as an advisory requirement because implementation of the requirement is judgmental and generally is only accomplished if there is little or no cost impact.

Advisory, or insignificant cost impact requirements were promptly dropped from further consideration. The remaining significant cost impact requirements have a number of TBD values or reported data made obsolete by recent ESRO documents. These requirements were made consistent with the requirements defined in the Spacelab RFP so that the reported cost delta did not reflect specification differences resulting only from the date of issue of the specification.

Next, the actual comparison of specification requirements was performed. Those NASA requirements causing additional modifications or engineering activities were identified. The costs of these modifications were then determined indicating a delta cost to the previously defined modification costs.

4.2.1 Areas of Disagreement

The significant delta cost impact areas of the EC specification requirements over the SEEIR are summarized in Table 4-2. Several other requirements potentially qualify for the table, but applicability to off-the-shelf experiment equipment is negligible and would not constitute significant cost deltas. The type of delta activity incurred by an EC specification requirement is indicated by an "X" in the appropriate column. The impacts identified are generated for all equipment. Specific items may have different impacts.

As the table shows, all the listed requirements require delta design evaluation efforts to define requirements, provide technical coordination, manage program implementation efforts and other aspects of project and systems engineering. These activities lead to additional customer review coordination, documentation, design reviews, and approvals in one form or another, to verify that requirements have been met.

4.2.1.1 Requirements Increasing Engineering Costs

Reliability, maintainability and material control activities usually have special program plans to identify specific requirements for specific items. The magnitude of the latter efforts are subject to the customer's wishes and, therefore, vary from program to program. An estimated middle-of-the-road stance was adopted, assuming that demonstration of compliance via documentation and/or testing was needed on a fairly austere basis.

Experimenters, interested in obtaining useful results, will generally demand satisfactory equipment operation. Therefore, imposed assurance-type efforts will result in insignificant delta redesign. The EC specification, however, implies program efforts to verify or demonstrate adequacy. Therefore, increased system engineering costs will be incurred by the NASA specification.

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Table 4-2. Delta EC006M Requirements Over SEEIR

TOPIC	EC006M PARAGRAPH	ESSENCE OF REQUIREMENT	ACTIVITY INCURRING DELTA COST			
			EVALUATION/ SYST ENGR	DATA/ APPROVALS	TESTING* NO REDESIGN	REDESIGN, + MOD & QUAL**
RELIABILITY	3.2.3	DEFINE AND CONFORM TO A RELIABILITY OBJECTIVE	X	X	X	
MAINTAINABILITY	3.2.4	PROVIDE EASE OF MAINTENANCE	X	X	X	
MATERIALS APPROVALS	3.2.6.3	NASA APPROVAL ON ALL MATERIALS APPLICATIONS	X	X	X	
NON-OPERATING TEMPERATURE	3.2.7.1	NO DAMAGE OVER -40 F TO +167F (-40 C TO 75 C) RANGE	X		X	X
NON-OPERATING PRESSURE	3.2.7.1	NO DAMAGE IN VACUUM FOR UNDEFINED TIME	X		X	X
TEST CONNECTORS	3.3.5.1.2	EXTERNAL TEST POINT ACCESS	X			X
MOISTURE SEALING	3.3.5.1.3	SEAL ALL CONNECTORS AND WIRING JUNCTIONS	X			X
SAFETY INTERLOCKS	3.3.5.1.4	DEMONSTRATE ADEQUACY	X	X		
LOOSE ACCESSORIES	3.3.6.1.3	INCORPORATE LOOSE ITEMS INTO BASIC ITEM WHEREVER POSSIBLE	X			
PVC	3.3.6.2.1	PROHIBITED--NO EXCEPTIONS	X			X
FUNGUS	3.3.8	NO UNTREATED NUTRIENTS	X	X	X	
CORROSION	3.3.9	NO METAL COUPLES PER CHART (MIL-SPEC)	X	X	X	
REPLACEABILITY/ INTERCHANGEABILITY	3.3.12.1	DEMONSTRATE ASSURANCE CONTROLS FOR INTERCHANGEABILITY	X		X	
HUMAN PERFORMANCE	3.3.15	MEET 10M33222 REQUIREMENTS 1/4-TURN FASTENERS, FRICTION HINGES, PANEL INSTRUCTIONS	X			X

*INCLUDES DEMONSTRATION TESTS, PARTS QUALIFICATION, DELTA ACCEPTANCE AND QUALIFICATION TESTS FOR AN UNMODIFIED ITEM

**INCLUDES ALL EFFORTS ASSOCIATED WITH THE MODIFICATION DELTA EXCEPT INITIAL EVALUATION FOR MODIFICATION REQUIREMENTS.

4.2.1.2 Requirements Causing Additional Equipment Modification

Nonoperating Temperature. The EC document specifies a -40 F (-40 C) to +167 F (75 C) nonoperating range. It is assumed that this could include worst case transportation conditions such as air cargo transport and dock area storage. The SEEIR specifies a nonoperating temperature of +40 F (4.5 C) to +130 F (54.5 C). The SEEIR implication is that the experimenter will be responsible to protect and/or ship by a nondamaging means and that Spacelab environment is compatible with commercial uses. Most equipment items examined specify or imply a nonoperating temperature range capability. Some provide acceptance tests or burn-in over a specified range. In general, the upper EC006M specified limit is not significantly higher than most equipment capabilities. Many appear to be impacted by the -40 F (-40 C) lower limit. It is estimated that 5 percent of an item's constituent parts are not capable of surviving the EC006M conditions. Additional thermal test chamber equipment and time will also be required in order to qualify and accept the redesigned item.

Nonoperating Vacuum. The EC specification requires a 0 to 15 psia range capability. The SEEIR requires 14.7 ± 0.25 psia. The slight delta overpressure by EC006M is negligible. The vacuum requirement could seriously impact parts; sealed components may explode. In addition, volatile lubricants may boil away during vacuum, making a unit inoperative. Significant additional test time is required to verify that the units can survive the vacuum environment.

For this study, 5 percent of the electronic parts of an item were assumed to be impacted by the vacuum environment. In addition, motors and other items requiring lubrication were identified so that replacement of lubricant with an acceptable type could be costed.

Test Connectors. The EC specification requires test equipment to mate with the item via test connectors. The worst case requirement would be for troubleshooting to logical replaceable assemblies. The SEEIR assumes that the usual method of troubleshooting or verifying performance is acceptable and does not specify a requirement.

In order to implement the requirement, it is assumed that one or more test connectors, a test harness, a test signal isolation circuit board and patch wiring on PCB modules through their connectors are required. Test connectors are 25 or 50-pin shell type as needed. More than one may be required. The number of test signals was estimated for each unit, ranging from 2 to 5 per replaceable assembly, depending upon item complexity and modularity. Spare PCB connector pins were assumed to be available for patch-wiring some signals from the boards.

To prevent loading, accidental short-circuit or other damage to sensitive signal sources, circuit isolation components must be installed. These may be installed on the PC boards. However, for costing it was assumed they would all go on a central special PCB to be fabricated. It was estimated that 25 percent of the signals would require isolation and that of these an average of 1 to 2 discrete electronic components would be required per signal.

It should be noted that it was assumed that the test requirement does not apply to replaceable assemblies that are tested out of the item. The EC specification does not make this clear, however.

Installation of test connectors largely meets the EC specification maintainability requirement. However, some items not modularly designed with plugable PCB's could require further redesign for ease of replacement. Redesign for ease of maintenance was identified for some units.

Moisture Sealing. The EC specification requires all connectors and wire junctions to be sealed. The SEEIR has no equivalent requirement. The rationale for the relaxation of this requirement is that normal practice should be sufficient for the currently planned Spacelab atmosphere.

Since the SEEIR requires encapsulation of PCB's in most cases for vibration and flammability reasons, it was assumed that all wiring junctions on the PCB's would be sealed, therefore, no delta would be required. Other junctions, besides connectors, are primarily at terminal strips. Therefore, the delta was assumed to consist of sealing or potting all connectors and terminal strips in each item. Some connectors are easier to seal than others. Printed-pin PCB connectors and some "auto harness" type molded mylar connectors will be very difficult to seal. The cost analysis assumes some percentage of connector replacements in addition to sealing. However, some PCB connectors may need re-sealing after each module removal/replacement. Two halves of internal connectors are sealed, while only one half of external interface connectors are sealed. Coaxial cable connectors are sealed as well as high-density pin connectors.

Polyvinyl Chloride (PVC) Replacement. The EC specification prohibits PVC without exception. The SEEIR allowed PVC in totally enclosed containers and on single loose wires. Costing delta consists of delta replacements of wiring (loose and harnesses) in sealed and totally enclosed units, unless it is TFE.

Human Performance Engineering. The EC specification requires NASA Specification 10M33322, "Man/Systems Design Requirements for Sortie Lab," to be met. Three requirements were judged to cause potentially significant cost increases:

1. All fasteners to be 1/4-turn self-contained.
2. All doors to have friction hinges.
3. Operating instructions to be silk-screened on an item's panel wherever possible.

It was assumed that each item would need at least four fasteners for rack securing. Also, any plug-in modules from the panel face would need such fasteners to replace existing thumbscrews, etc. The latter requirement affects NIM modules as well as commercial oscilloscopes, RF analyzers, etc.

All item doors were assumed to have hinge replacements.

All items were assumed to have some silk-screened instructions placed on panels except oscilloscopes and voltmeters. These two units were exempted for two reasons: (1) the panels on these are too crowded, and (2) operation of such familiar devices should not require special instructions. Instructions are assumed to be proportional to the number of panel controls. Some controls have little space available but effort to "design" the right words for this problem will offset the lack of available space.

4.2.2 Impact of EC006M00000A on Selected Equipment

This section provides a detailed summary of the delta modifications resulting from the EC specification as compared to the SEEIR. The basic modification information is discussed in Section 4.2.2.1, while detailed costs are summarized in Section 4.2.2.2.

4.2.2.1 Modifications

Table 4-3 lists the EC006M delta modifications for 31 items. The blood cell counter, freezer, and dewar were omitted from the list since these items could only be custom built. The modifications were determined by inspection and data similar to the manner in which they were previously defined. The following is an explanation of the data contained in Table 4-3.

Vacuum and Thermal Impacts. The nonoperating temperature and non-operating vacuum columns estimate the new parts and test facilities, including test time, needed to satisfy the NASA specification. As a general rule, one half of the parts replaced were assumed to be different. In the case of the Neff amplifier, a fewer number of part types is needed because the assembly consists of 16 identical modules.

As a general rule, 5 percent of the total parts count is estimated to need replacement to satisfy the additional thermal requirements if specifications indicate qualification below 0 F (-18 C). If the current manufacturing practice essentially meets the EC006M requirement, then no parts replacement is required. If the current practice lies somewhere between about -30 F (-34.4 C) and 0 F (-18 C), then 2.5 percent of the parts are assumed to need replacement. The laser was felt to be a special case where internal temperature control is needed to avoid low temperatures that could affect critical optics alignments. A heater and thermal switch were added to the unit.

A similar approach was used to estimate replaced parts for vacuum exposure. However, it was assumed that all items with significant populations of electronic parts would require the same replacement rate. That is, no reduction was assumed for parts qualified for 55,000 feet (1.68 km). The RHG transmitter was an exception because available information indicates a minimum usage of conventional discrete electronic packaging for active devices. The stripline and hybrid circuit type construction in the transmitter indicates a reduced potential for the problems often caused by vacuum; therefore, no replacements were required.

Table 4-3. EC006M Delta Modification Summary

ITEM	Non-Operating Temperature – Parts – Replace	Non-Operating Temperature – Parts – Revise Specs	Non-Operating Temperature – Testing	Non-Operating Vacuum – Parts – Replace	Non-Operating Vacuum – Parts – Revise Specs	Non-Operating Vacuum – Lubrication	Non-Operating Vacuum – Testing	① Number of Test Signals	Assemblies	Connector and Junction Sealing – Internal – Standard	Connector and Junction Sealing – Internal – Printed Circuit Bd.	Connector and Junction Sealing – Internal – Terminal Board	Connector and Junction Sealing – External – Standard	Connector and Junction Sealing – External – Printed Circuit Bd.	Connector and Junction Sealing – External – Terminal Board	P/C Replacements – Harness Wires	P/C Replacements – Loose Wires	Human Factors – Control Panel Instructions	Human Factors – Captive Fasteners	Human Factors – Friction Hinges	Maintainability Redesign
KEYBOARD TERMINAL	25	*	NEW	25	*		NEW	25	5		7		1				50	53			X
SPECTROPHOTOMETER	50	*	NEW	50	*	2	NEW	50	16	10	8		3				50	10		X	X
TAPE RECORDER (AMPEX)				100	*	4	NEW	50	50		66		4			150	50	10	6		
TAPE RECORDER (HONEYWELL)				100	*	6	NEW	50	30	40	25	4	3				50	10	6		
COMPUTER	75	*	NEW	75	*	2	NEW	50	20	5	60		6				100	22	4		X
MULTICHANNEL ANAL (ND 100)	100	*	NEW	100	*	2	NEW	50	13	10	7		8				100	32	4		
TIME CODE GEN (DATATRON)	20	*	DELTA	40	*		NEW	25	5		4		10				25	10	4		
POWER SUPPLY, NIM (P.D.)	7	*	NEW	8	*		NEW		1				1				50		4		
LASER	②	②		10	*		NEW	15	3			1	1			25	15	2			
VOLTMETER – 8200A				60	*		NEW	50	15		12		2	3			50				
VOLTMETER – 8125A				35	*		NEW		1								10				X
TIMER COUNTER (TENNELEC)	25	*	NEW	30	*		NEW	25	3		4		10					10	12		
RF SPECTRUM ANAL (SINGER)				30	*		NEW	50	8	7	15		6			105	100	39	8		
EMI METER (SINGER)				100	*		NEW	100	30	32	22		7					13	4		
FREQ SYNTHESIZER – 645M	100	*	NEW	100	*		NEW	100	30				16			60	100	18	4		
MICROSCOPE ③									5												
CENTRIFUGE						1			2									1			
POWER SUPPLY (SORENSEN)				25	*		NEW	25	4	4					2		200	7	4		
GAS CHROMATOGRAPH	90	*	DELTA	90	*	1	NEW	15A	3A	5P	7P		1P					15	4P	XA	XA
ELECTROPHORESIS SYSTEM ④	60	*	NEW	60	*	2	NEW	50	13	4	10						200	10		X	
AMPLIFIER	100	9	NEW	100	9		NEW	75	17		17		2					64 ⑤	4		
CRT STRIP RECORDER	50	*	NEW	50	*	4	NEW	150	45	3	36		36				50	31	4		
VHF TRANSCEIVER (COLLINS)			DELTA	100	*		NEW	50	11	6			2			100	50	6			
TRANSMITTER (RHG)						1	NEW	50	10			3					50	9	4		
NIM COUNTER ASSY (ORTEC)	40	*	NEW	40	*		NEW	25	5	5			5				50	10	16		
RF SPECTRUM ANAL (H-P)				160	*	2	NEW	50	12	8	20	1	5				175	22	6		
FURNACE									2									4		⑥	
OSCILLOSCOPE (TEKTRONIX)				100	*	1	NEW	100	15	20			9				50	21			X
OSCILLOSCOPE – MIL (H-P)				75	*		NEW	50	5	5							100				
MICROTOME						2			2									8		X	
pH METER	5	*	NEW	5	*		NEW	15	3		2		3				50	6		X	

① ESTIMATED SIGNALS NEEDED TO EXTERNALLY IDENTIFY FAILED REPLACEABLE ASSEMBLY (IN CONJUNCTION WITH AVAILABLE INPUT-OUTPUT AND DESIGN CHARACTERISTICS).

② ADD HEATER AND THERMAL SWITCH INSTEAD OF PARTS REPLACEMENT.

③ INCORPORATE LOOSE OPTICAL FILTERS AND/OR WHEELS INTO DESIGN.

④ INCORPORATE CELL AND POWER SUPPLY INTO UNIT DESIGN.

⑤ GROUP OF FOUR, REPEATED EACH AMPLIFIER MODULE.

⑥ INCORPORATE FURNACE ACCESS COVER WITH FRICTION HINGES.

* ASSUME ONE NEW SPEC FOR EACH TWO PARTS REPLACED.

A = ANALYZER ONLY

P = PROGRAMMER ONLY

Lubricants may require replacement if exposed to vacuum, depending upon sealing and duration of exposure. The items that contain significant lubricants (in terms of replacement costs) were identified by the number of lubricated assemblies such as motors, linkage assemblies, etc. The Honeywell tape recorder, for instance, contains three tape-handling motors, two fan motors, and pinch-rollers, a total of six lubricated assemblies. The CRT strip recorder has one motor, one tachometer and a paper-handling roller assembly, i.e., three lubricated assemblies. The microtome has numerous gears, ratchets, etc., making up two lubricated assemblies.

Test Connector Signals. Estimates of the number of test signals required for each item were based upon assessment of the number of logical assemblies that were functionally independent and could be repaired or replaced. As explained previously, wiring harness, connector, signal isolation circuitry and PCB rework requirements were estimated from this information.

Moisture Sealing. A count of internal and external connectors and terminal strips/boards was made to estimate sealing requirements. Connectors are divided into standard and printed-pin PCB type. These categories represent different sealing problems that could result in significantly different relative costs. Access to each connector for sealing is a function of the concerned item.

PVC Replacement. Estimates are provided for the wires in harnesses that are in totally enclosed units and therefore not replaced due to the SEEIR. No entry (-) indicates no PVC in the item (either no wiring, or TFE is reportedly used).

Human Factors. The number of controls per unit is shown since this indicates the effort required to define and apply silk-screened panel instructions. No entry (-) indicates no controls (NIM power supply) or the requirement for instructions is assumed to not be possible due to panel control density.

The number of captive 1/4-turn fasteners for each item is based on the assumption that rack-mounted units attach by their front panel and require at least four per item. The tape recorders were alloted two additional fasteners to provide more support for vertical rack mounting. Where panel access to replaceable modules are used, the mounting screws (usually thumbscrews) are replaced with the required fastener. Where new rack-mounting brackets were required by SEEIR and logically could include the fasteners with negligible added cost, a fastener delta for the EC specification was not estimated.

Finally, all doors or lids with hinges were identified and replaced to meet the EC006M and 10M33222 requirement for friction hinges.

4.2.2.2 Delta Modification Cost Analysis

The additional costs incurred by requiring the selected equipment items to conform to the EC006 specification are of two types. The first type includes additional modifications identified to satisfy the requirements of this specification which are in excess of the study-developed specification. A second cost type, particular to the EC006 specification, includes additional engineering requirements which were not associated with a modification. These costs reflect the additional analytical, testing, and reporting efforts typical of most aerospace-type specifications.

Approach. The approach to defining each cost element is similar to the approach explained for the determination of modification costs in section 3.0. The delta activities were categorized as follows: vacuum and thermal capability, test connectors, sealants, wiring, fungus, corrosion, material control, safety interlocks, interchangeability/replacement, maintainability, reliability, and parts replacement. Wherever possible a count of hardware was estimated and used as a basis for estimating, at a grass roots level, the number of engineering and manufacturing hours required to perform the required tasks.

The engineering tasks include parts identification, requirements documentation, vendor coordination, test procedures, wire definition, test signal selection, connector and harness design, circuitry and voltage analysis, materials analysis for fungus control, elimination of electrolytic couples which might corrode, maintainability design, documentation and customer approval, reliability predictions and change identification. A major input is the systems engineering effort to make these identifications and ensure consistency with the Spacelab requirements. Each of these tasks were reviewed individually by hardware item to ensure first that the effort was a requirement, and secondly, that no overlap or omission occurred. The hours were then extended by the appropriate rate which included labor, burden, and administrative expense to project the total cost.

To determine the manufacturing cost impact, man-hour standards were utilized to estimate the cost of modifications derived by engineering. These standards are the same as applied in the cost analysis of the first set of modifications and were applied to fabrication, material, quality assurance, and test procedure costs.

The test effort required was projected by engineering personnel and related to the changes required to meet the NASA specification. Caution was taken to avoid any duplication and where appropriate, such as in vibration tests, it was assumed that the test estimate for the original modification was adequate and would be performed at the conclusion of the modification program whether the study specification or EC006 specification was applied. In either case, this test is performed only once.

The same factors used for the original modification costs were applied to the documentation and project management costs; i.e., documentation equals 10 percent of engineering, manufacturing, test and program management equals 5 percent of total cost.

<u>Results</u>. Hardware modification costs are significantly impacted by an aerospace-type equipment specification. The average cost of hardware modified to the MSFC specification is twice the magnitude of the average cost incurred when equipment is modified to the study-developed specification. Table 4-4 summarizes the cost impact by equipment item and function. The basic cost categories are itemized including a breakdown of engineering costs into costs incurred by the modification of hardware and those incurred by systems engineering activities necessary to satisfy the EC006 specification. The total cost of additional modifications are shown for each unit. Adding this cost to the cost of the modified hardware described in Section 3 establishes the total cost of each item when modified to meet the EC006 specification.

Fabrication costs are lower relative to modification engineering costs than generally estimated for the equipment modified to SEEIR requirements. This lower multiple results from inclusion of assembly, disassembly, certification, and general manufacturing support costs with the previous modifications. The fabrication costs shown in Table 4-4 reflect only the specific manufacturing activities related to the delta modification required.

The test costs did not vary as much between equipment items as it did in the previous modification activity. Testing in support of materials control requirements of the EC006 specification and a maintainability demonstration cause this smoothing of test costs. The cost of testing materials to identify their toxicity and flammability characteristics were apportioned equally across all equipment items, since this information is applicable to more than one equipment type. (Information regarding the characteristics of a specific material would apply to all units containing that material.) Cost of a demonstration of ease of maintenance was also assessed against each unit. The cost of these tests was much higher than the cost of all other delta testing associated with the EC006 specification. Therefore, major differences in test costs did not result.

The cost of the additional modifications and system engineering amounted to $936K for the 31 units modified. This amount is nearly the same as the cost of modifying the hardware to meet the SEEIR. The sum of these two costs equals the cost of modified hardware satisfying the EC006 specification. As Table 4-4 shows, a major fraction of the cost of meeting the EC006 was incurred by the systems engineering activities necessitated by the specification. The SEEIR minimizes reporting activities, eliminating the need for much of these costs.

Figure 4-2 compares the cost of modifying each of the selected equipment items to the EC006 specification or the study-developed equipment specification (SEEIR). The shaded area in each bar represents the cost of modification to the SEEIR. The total height of each bar is the cost of modifying the equipment to the EC006 specification. The blank area then represents the cost added by the EC006 specification.

Modified hardware costs doubled when the requirements of the MSFC specification are met. The average cost of the selected hardware is $62,000 as compared to $32,000 for the average cost of the hardware modified to the SEEIR. The average of the ratios of modification cost to retail cost rises from 8 to 18 when the NASA specification is imposed. The ratio of the total modification cost to the total retail cost rises from 4 to 10.

Figure 4-3 compares the hardware modified to the EC006 specification with estimated cost of the same hardware custom built. This figure should be

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Table 4-4. Delta Modification Cost Summary*

UNIT	MANUFACTURER	FABRI-CATION	MODIFI-CATION ENGR	SYSTEM ENGR	TEST	DOCUMEN-TATION	PROGRAM MGMT	TOTAL MODIFICATION COSTS		
								DELTA FOR EC006	TO MEET SEEIR	TO MEET EC006
TAPE RECORDER	AMPEX	4,840	13,760	15,919	5,594	2,562	2,133	44,808	58,222	103,030
	HONEYWELL	1,763	13,204	15,040	5,502		1,903	39,974	49,531	89,505
COMPUTER	DEC	2,233	12,480	13,475	5,649		1,820	38,219	62.293	100,512
	DATATRON	690	5,620	9,008	5,262		1,157	24,299	21,598	45,897
	TENNELEC	725	3,016	8,171	5,382		995	20,869	14,213	35,082
SPECTROPHOTOMETER	BECKMAN	999	8,690	16,757	5,465		1,725	36,197	51,385	87,582
EMI/FIELD INTENSITY MTR	SINGER	1,657	13,928	13,929	5,410		1,874	39,360	37,767	77,124
TRANSMITTER	RHG	424	4,985	12,679	4,876		1,276	26,802	17,933	44,735
TRANSCEIVER	COLLINS	907	9,675	12,791	5,318		1,563	32,816	15,177	47,993
AMPLIFIER	NEFF	1,421	10,620	12,104	5,686		1,620	34,013	22,736	56,749
SPECTRUM ANALYZER	H/P	1,727	16,080	19,450	5,851		2,284	47,954	48,099	96,053
	SINGER	1,255	8,600	11,125	5,483		1,451	30,474	30,402	60,876
MULTICHANNEL ANALYZER	NUCLEAR DATA	1,447	15,000	16,206	5,741		2,048	43,024	37,288	90,312
FREQUENCY SYNTHESIZER	FLUKE	1,524	18,120	16,361	5,851		2,209	46,627	37,352	83,979
LASER	SYLVANIA	258	2,720	7,749	4,637		896	18,822	35,015	53,837
GAS CHROMATOGRAPH	BECKMAN	971	10,430	13,038	5,391		1,620	34,022	44,968	78,990
VOLT/OHM METER 8200	FLUKE	872	4,965	10,556	5,170		1,206	25,331	20,889	46,220
8125A	FLUKE	133	2,776	8,687	4,582		937	19,677	15,156	34,833
OSCILLOSCOPE	TEKTRONIX	1,143	13,270	25,912	5,362		1,910	40,115	35,243	75,358
	H/P	698	8,555	13,157	5,005		1,499	31,476	25,407	56,883
ELECTROPHORESIS	BECKMAN	1,240	10,705	12,939	5,778		1,626	34,150	114,175	148,325
PARTICLE COUNTER	ORTEC	854	9,160	12,908	5,341		1,494	31,369	18,778	50,147
pH METER	BECKMAN	396	2,866	7,960	5,170		898	18,582	21,431	40,013
KEYBOARD DISPLAY	RESEARCH	614	5,190	14,848	5,281		1,175	24,665	35,542	60,207
CENTRIFUGE	CLAY-ADAMS	-	-	7,544	4,420		800	15,362	9,365	24,727
MICROSCOPE	AMER OPTICAL	-	-	6,164	4,420		707	13,853	19,186	33,039
FURNACE	ASTRO	-	-	11,500	4,420		1,066	19,548	25,545	45,093
MICROTOME	AMER. OPTICAL	-	-	6,311	4,420		719	14,012	11,697	25,709
POWER SUPPLY	SORENSEN	719	4,140	8,372	5,373		1,058	22,224	20,015	42,239
	POWER DESIGN	318	3,840	8,801	4,766		1,014	21,284	14,680	35,964
STRIP CHART RECORDER	HONEYWELL	2,191	19,130	14,229	5,823	2,562	2,197	46,142	32,725	78,867
TOTAL		32,079	251,525	380,685	162,479	79,422	44,880	936,070	1,003,813	1,939,883

*COSTS ARE GIVEN IN DOLLARS

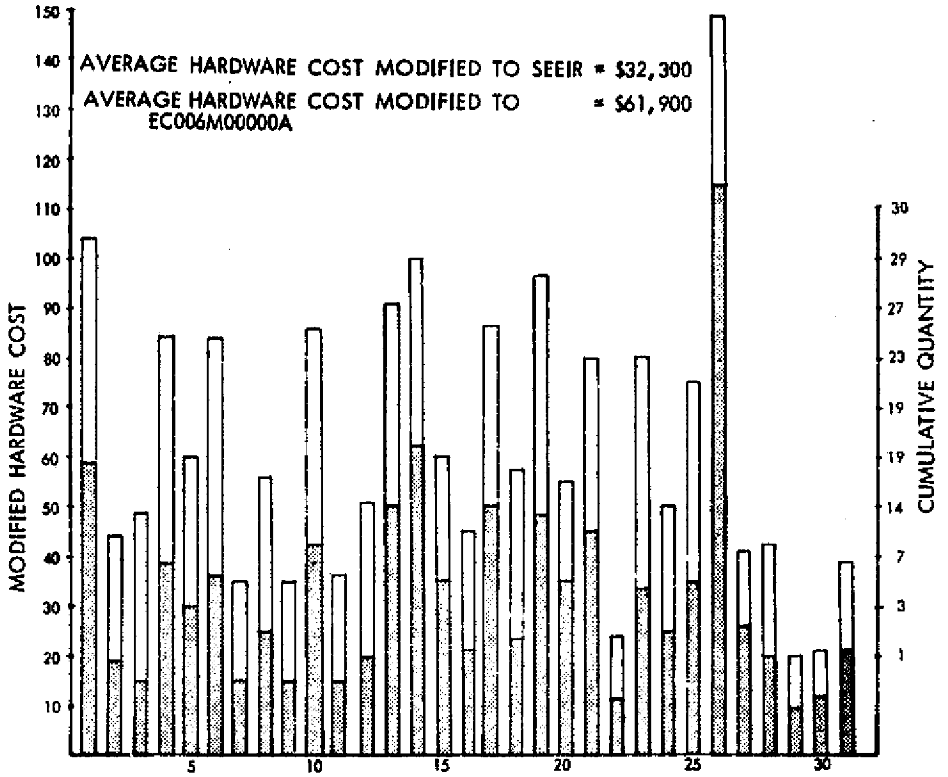


Figure 4-2. EC006M00000A Versus SEEIR Modification Costs

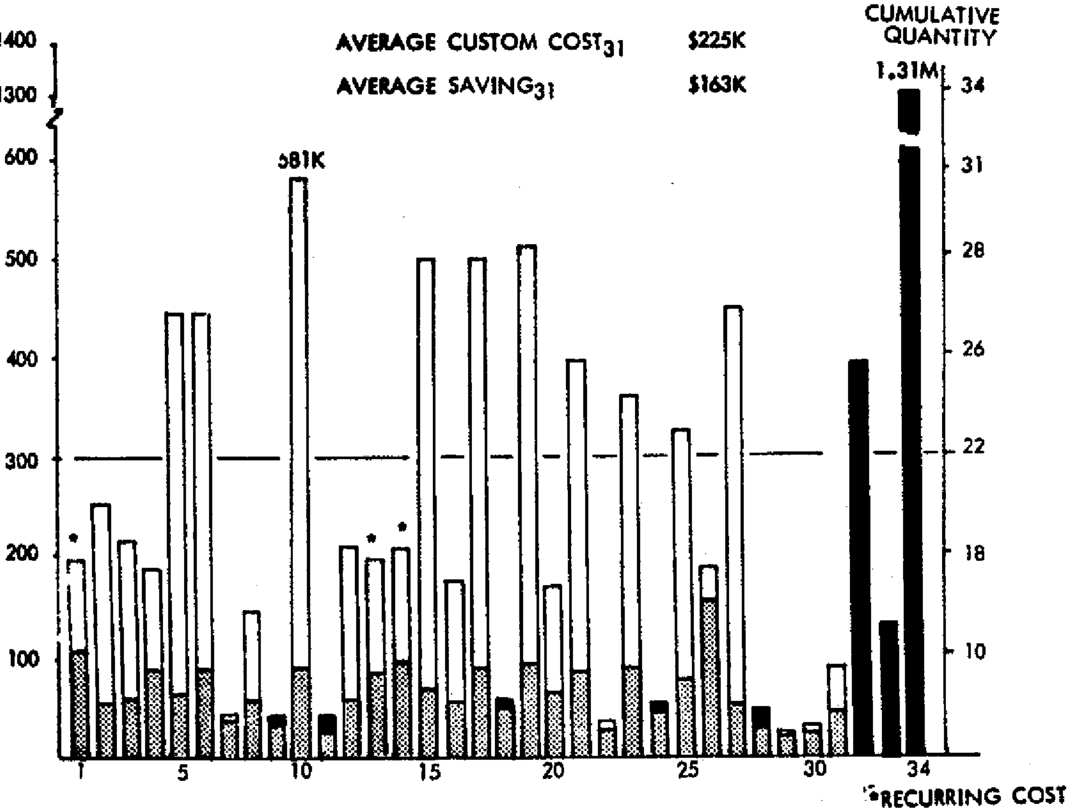


Figure 4-3. Modified Versus Custom Costs

compared to Figure 3-36. Previously, all 31 items modified were estimated to cost less than the cost of equivalent custom-built hardware. Enforcement of the EC006 specification caused five of these items to have modification costs in excess of their custom costs. The Tennelec timer/counter, the Power Designs power supply, the Neff amplifier, the Fluke Model 8200 volt-ohm meter, and the Sorensen power supply can be more cost effectively procured if custom built in this case. The excess of the modification cost above the custom-built cost is shown in black on the bars of these units. The average savings on all 31 modified units dropped from 5195K to $163K. Therefore, application of either specification results in the same conclusion--use of commercially available equipment and instrumentation is cost effective when compared to custom-built hardware.

The average per-unit savings is still large even though the EC006 specification is applied. However, a potential savings of $25 million could result to the program if the SEEIR specification where used rather than the EC006 specification. Review of the specification comparison presented in Section 4.1 indicates that the requirements of the EC006 specification could be relaxed without affecting the performance, reliability or safety of the experiment equipment. Therefore, adopting equipment requirements consistent with those defined in the study-developed specification is recommended.

4.3 ALTERNATIVE SPECIFICATION REQUIREMENTS

The study thus far has examined the requirements and costs of modifying CAM equipment to meet specified requirements for placement in the Spacelab. An alternative to modifying equipment is relaxing these specified requirements allowing available equipment to be placed on board with as little modification as possible. This section explores possible changes to the Spacelab equipment specification. Candidate requirements for tradeoff were identified by examining the characteristics of the CAM equipment in the available configuration, the modifications identified in Section 3.0 to make the equipment suitable for installation in the Spacelab, and the differing requirements identified by the specification comparison discussed in Section 4.2.

Results are presented of tradeoffs of alternative specifications for the vibration environment, material control requirements, and corrosion and fungus control, along with an analysis of the impact of changing equipment to be compatible with the 28 vdc primary Spacelab power source. Detailed tradeoff information is presented in Volume III.

4.3.1 CAM Equipment Rack Vibration Isolation

4.3.1.1 Objective

The suitability analysis determined that almost all items would require modifications to meet the ERNO Spacelab vibration spectrum used in the SEEIR specification. Sixty to 80 percent of the total CAM modification costs apply to vibration modifications. While the evaluations show that the modifications are highly cost effective, compared to the cost of custom equipment, these modifications could be significantly reduced if the items were more effectively isolated from the Spacelab vibration. Therefore, it is appropriate to

investigate the feasibility of vibration isolation and to evaluate the costs of several alternative methods.

The tradeoff is directed primarily at standard rack-mounted equipment because 25 of the 34 items studied were suited for such mounting. However, study results could just as well apply to the five items that were found to be unsuited to standard rack mounting by assuming the use of a special rack or bench with similar isolation.

4.3.1.2 Comparison of Alternatives

There are many possible system solutions to isolate the equipment items. Isolation can either be active or passive. Active isolation is not cost-effective for the smaller equipment clusters. It may be potentially effective for a number of consoles mounted in one rigid system. It may also be cost-effective at the total Spacelab level since costs would be shared by all equipment items.

Low-frequency passive isolators are feasible at the unit, rack, or group-of-racks levels. They would be less desirable at the total Spacelab level because of the resultant interface complexities from large peak displacements. The assessments made were therefore aimed at the potential of (1) passive isolation of equipment units in hard-mount racks, (2) hard-mounting of units in passive isolated racks, and (3) hard-mounting of units in racks that are hard-mounted in groups to a passively isolated framework.

Isolated Equipment Units in Hard-Mounted Racks. The most straightforward isolation approach would be to isolate each item in an equipment rack. This alternative is not cost-effective and impacts the physical dimensions of the rack. Development of an isolator effective in the low-frequency range necessary for the equipment is estimated to cost $150 thousand. Since isolators are custom built to the characteristics of the package attenuated, this cost would be incurred for each package with dissimilar mass or resonance characteristics. The cost of the internal modifications of each package averaged $10,000 and is therefore more cost-effective. The excursions of the vibrating equipment could be up to $\pm$1.5 in. (3.8 cm). These excursions would necessitate the construction of an over-sized rack, impacting the Spacelab design. Inter-unit connections would also be impacted by these excursions.

Rack and Multi-Rack Isolation. Distribution of the costs of isolator development among more equipment items by either isolation of a rack or a group of racks is more cost-effective. The most serious potential problem is that total weight variations in each rack may require custom isolators. The flexibility of using Spacelab would be affected. Either the isolators could not be designed until the rack was loaded, or extensive coordination would be needed to assign equipment items to racks and establish weight goals. Neither is compatible with a flexible user policy. This problem would be solved if a standard range of isolator designs were made available to accommodate various weight ranges. This issue requires an in-depth study to verify design feasibility and to establish the required design parameters.

4.3.1.3 Conclusions

The following conclusions were made during the tradeoff study:

1. Grouping of equipment items into multiple-rack isolated systems would be cost-effective provided that the proper isolators are made available for the spectrum of weights and mass distributions. Isolation of individual equipment items within racks is, as a general rule, impractical and not cost-effective.

2. A test program should be undertaken to understand the true non-operating vibration environment capability of CAM equipment. Two thirds of those items studied were not tested to a defined vibration spectrum. Data for the other one-third quoted mostly sea-going vessel specifications for operating conditions and many may be capable of more stringent low-frequency inputs.

4.3.2 Material Control Tradeoff

4.3.2.1 Objective

The objectives of this trade study are to (1) determine whether it is feasible to reduce the Spacelab internal experiment equipment material control requirements from the level defined by the NASA equipment specification (EC006M00000A) to the study SEEIR specification, and (2) determine whether it is feasible to eliminate all material control requirements (except for mercury, cadmium and zinc).

The first objective was evaluated by a risk analysis which considered the cost differential between imposing the study SEEIR specification requirements and the NASA specification requirements upon the equipment, compared to the cost of modifying and reflying experiments which failed because of a material control type of problem.

The second objective was evaluated by comparing the cost savings expected by further relaxing the study specification material control requirements, with the costs of adding an active method of cleaning the Spacelab environment of increased outgassing products or isolating the increased outgassing products.

4.3.2.2 Discussion of Results

Relaxation of the material control requirements of the EC006 specification to the requirements of the SEEIR does not reduce crew safety and is cost-effective. The specifications differ only in the depth of material identification required and the treatment of enclosed units. The 150-hour bakeout required for all units by the SEEIR and conformal coating of printed circuit boards eliminates the need for identification of all materials. Enclosed packaging restricts co-mingling of the package atmosphere with the habitable environment. Therefore, both specifications are equally safe.

A risk analysis was used to evaluate the cost-effectiveness of relaxing the material control requirements down to the level of the study equipment specification. Relaxation of a specification increases the risk of equipment failure.

The results of the risk analysis are shown in Figure 4-4. The horizontal line represents the cost differential between the NASA and the study level of

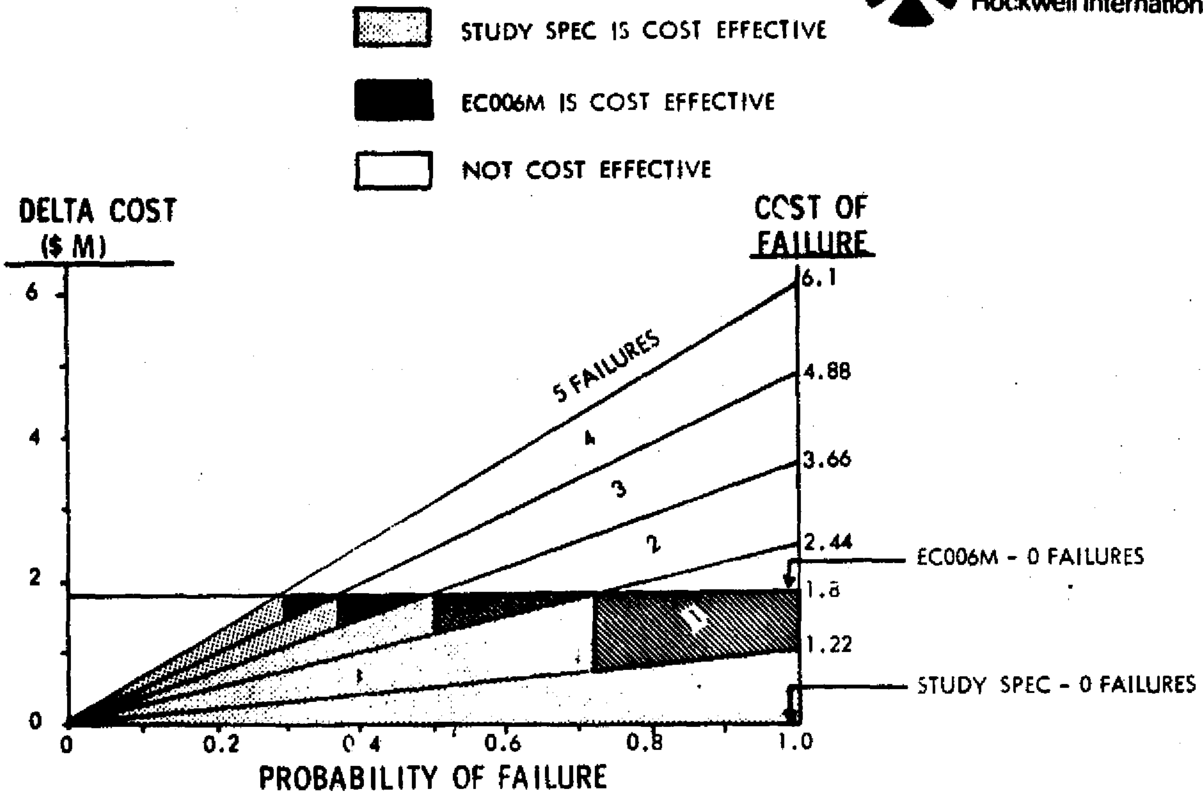


Figure 4-4. Risk Analysis for Relaxing Material Control Requirements from NASA Spec to Study Spec

material control requirements. This line represents the additional cost of identifying all materials in the equipment, approving the listed materials, and replacing any wire runs (internal and sealed units) from PVC to Teflon insulated wire. Since the cost is not probalistic, because it would be expended for all items of equipment, it is represented as a horizontal line. The slanted lines represent the expectation of incurring the cost of modifying up to five units that failed due to a material failure. Since such a failure is probabilistic, the expected cost varies with the probability of occurrence. For example, the probability of five equipment failures occurring during the program may be only 1 in 10. Therefore, the expectation is only about $700 thousand. Another way of explaining this cost is that with a probability of 1 in 10, the total cost of five failures would only be incurred once in ten experiment programs. Therefore, one-tenth the cost of these five failures is apportioned to one experiment program.

The cost of a failure is based on the cost to refly the failed experiment hardware and the cost to fix that hardware prior to reflight. Ten experiments are assumed to fly on any Spacelab; therefore, one-tenth the cost of reflying the Spacelab is assessed against that experiment. The cost per flight used was $10.45 million (1974 dollars) which is an average cost for 439 flights.

The intersection of the slanted and horizontal line defines the probability of occurrence where the cost of imposing the EC006 specification equals the cost of relaxing the specification to the SEEIR requirements. If only one failure should occur, it is always cost effective to relax the specification. The probability of two failures occurring during the program has to exceed 0.72 to make imposition of the EC006 specification cost effective. The probability must be greater than 0.5 for three failures to occur to make the EC006 specification cost effective and so forth.

The differences between the two specifications are small and should not result in significantly different failure rates. The major cost difference results from different material reporting requirements. An increased risk exists only for enclosed units. The SEEIR allows materials to exist in these units which would not be allowed by the EC006 specification. In the opinion of the study team, the probability of a material failure causing an equipment failure is not significantly different for the two specifications. It is believed that the probability of two failures occurring as a result of the specification differences is much less than 0.72. The probabilities for additional failures are also much less than the cross-over points shown on the figure. Therefore, relaxation of the EC006 specification to material control requirements defined by the SEEIR specification is recommended.

Elimination of all material control requirements was also examined. Total isolation of all equipment, or addition of a catalytic burner and appropriate sorbents to the Spacelab environment control subsystem (ECS), were examined. Equipment could be placed in a sealed rack charged with an inert gas to prevent fire. Sealing of the rack prevents toxins evolved from the equipment from entering into the habitable environment. Scrubbing of the atmosphere to maintain trace contaminants in the atmosphere below allowable thresholds can be accomplished by modifying the Spacelab ECS. Fire extinguishers would also be required to control a fire in this latter case.

Both alternatives are not cost-effective and were rejected. The inert gas isolation approach would cost at least as much as instituting a materials control program and would only be effective for the rack-mounted equipment. Sealing of rack-mounted hardware would require equipment modifications as extensive as those required to meet the material control specifications identified in the Spacelab/Experiment Equipment Interface Requirements (SEEIR) document. Isolation of bench-mounted equipment requires special packaging and could affect equipment operations. Most likely, a materials control program would still be necessary for these packages. Institution of a materials control program for a portion of the equipment would not achieve the objective of further relaxation of material control requirements.

The contaminant removal subassembly and fire extinguisher approach also is not cost effective. Development of a catalytic burner and associated sorbent beds is estimated to cost \$5.7 million. Each unit installed in a Spacelab would cost an additional \$0.8 million. If three Spacelab modules are required for the Sortie Experiment program, a total cost of \$8.1 million would be incurred. The cost of fire extinguishers is negligible by comparison, and has been recommended by the Phase II Spacelab study. The \$8.1 million cost does not compare favorably with the estimated programmatic cost for modification of equipment to meet the requirements of the SEEIR specification, which is \$3.7 million.

4.3.2.3 Conclusion

Reduction of material control requirements to a level defined by SEEIR is cost-effective. A risk analysis showed that the costs incurred by a failure resulting from relaxed material controls are less than the cost of imposing the NASA equipment specification. No compromise to crew safety is envisioned by implementing the study-developed material control requirements.

Further specification relaxation is not recommended. The cost of removing the increased offgassing products by means of a catalytic burner or the isolation of the offgassing products by cooling all rack-mounted equipment with a closed, gaseous nitrogen system exceeded the cost of implementing the study-developed material control requirements. More important, crew safety could very well be jeopardized by the increased amount of offgassing products if special precautions were not exercised.

4.3.3 Moisture and Fungus and Corrosion Requirements Tradeoff

4.3.3.1 Objective

The NASA specification for CAM equipment currently requires all materials used to be non-nutrient to fungus growth, or treated so the exposed surfaces will be fungus resistant. Also, the specification requires all metals to be corrosion resistant or to be processed to resist corrosion. Both of these requirements are intended to protect ground signal equipment from the deteriorating effects of climatic and service conditions encountered in military use.

The objective of this trade study then is to determine if the requirements for moisture and fungus resistance, and corrosion resistance (as stated in NASA Specification EC006M00000A), can be waived without significantly reducing the life of the equipment.

4.3.3.2 Tradeoff Conclusions

It is recommended that the EC006M00000A requirements for moisture and fungus-resistant materials be waived. The basis of this recommendation is as follows:

1. Ground operations for Spacelab, being studied for the NASA under Contract NAS1-12933, implements a study ground rule requiring a 50-percent relative humidity (or less) environment for all Spacelab ground operations including experiments. Studies have shown that relative humidities below 50 percent will not promote fungus growth nor electrolytic couples.

2. Periodic flight operations at 70-percent relative humidity (maximum) are not of sufficient duration to promote fungus growth and/or corrosion.

4.3.4 Power Distribution for Experiment Equipment Study

4.3.4.1 Objective

The issue addressed by this tradeoff is whether it is more cost-effective to modify experiment equipment items to utilize primary 28 vdc directly than to convert this power to 115 vac (60 and 400 Hz) and 220 vac (50 Hz) to be compatible with the equipment as currently designed.

Conversion of the 28 vdc Spacelab primary power to various voltages and frequencies for input to these units (with subsequent reconversions to internal secondary voltages) represents a double conversion loss. Such conversion

losses directly reduce the amount of available useful power, increase the heat rejection requirement for a given experiment load, and increase the weight of the conversion hardware. However, 28 vdc primary power may also not be a convenient power form, thereby also incurring conversion losses. This analysis compares the main elements of both power conversion systems in order to determine the relative electrical efficiencies, weights and costs involved.

4.3.4.2 Discussion of Results

The two alternative concepts shown in Figure 4-5 were compared with respect to conversion efficiency, weight and cost. No clear advantage exists for the efficiency of either alternative. Both concepts actually operate as dc-dc converters. The main difference is that the ac approach uses an extra transformer and harmonics filter. Also, the conversion frequency for the typical dc-dc converter is much higher in order to use low-cost parts and decrease weight.

Typical ranges of power losses for the key components used in the two approaches are noted in Figure 4-5. Without detailed designs, a clear-cut efficiency advantage cannot be shown for either approach, but some advantage is indicated for the ac approach.

Dc-to-ac inverters in the kw range typically operate with a loss of 10 to 15 percent. An Apollo inverter unit had a loss of 15 percent, for instance. Smaller inverters and dc-dc converters exhibit greater losses due to the greater proportion of power required by chopper and regulation electronics. However, available space in a package, left by the removal of its power supply, will probably not be adequate to accommodate efficient transformers in the dc-dc converter. The transformers used in the dc-dc converter concept would probably be less efficient than the transformers in the ac concept.

The delta weight between the two approaches is comprised of differences in component weights and support hardware weights. Table 4-5 summarizes the weights of the main elements for each system. A significant weight saving is indicated with high-voltage ac power distribution as compared with low-voltage dc power distribution.

The weight of support systems (reactants and heat rejection), incurred by the delta inefficiencies between the two approaches, can be discounted since the efficiency evaluation showed little difference between the two systems.

The ac power distribution approach requires no power supply modifications in the experiment units, but will require development of Spacelab power conversion equipment to provide the standard voltages and frequencies required by the experiments.

The dc power distribution approach requires no Spacelab power conversion equipment for experiments (some will be required for Spacelab subsystem equipment), but will require extensive redesign and modification of almost all experiment units. Due to the large number of combinations of internal

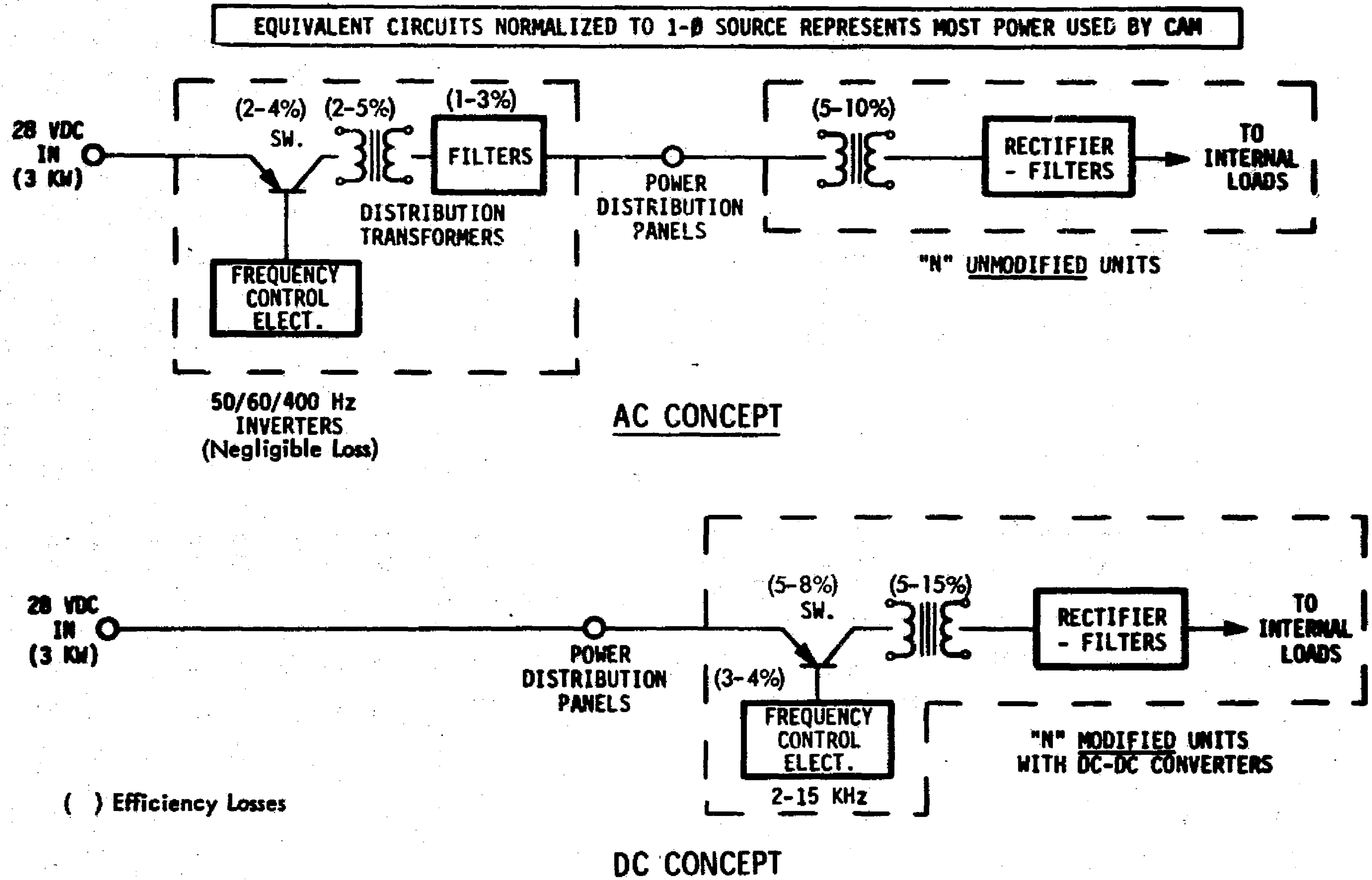


Figure 4-5. Equivalent Circuits for Power Distribution Alternatives

Table 4-5. Delta Weight Summary - Pounds (Kilograms)

Based on 3 kw Distribution; 2% Line Volt Drops; 100 ft, 2-Wire Systems

Concept	Electronics	Transformers		Distribution		Total Weight
		Units	Distribution	Filters	Wiring	
60 Hz ac	5	60 (27)	92 (42)	9-28 (4-13)	16 (7)	182-201 (83-91)
400 Hz ac	5	60 (27)	41 (19)	4-13 (2-6)	16 (7)	126-135 (57-61)
DC	29 (14)	29 (13)	--	--	256 (116)	314 (143)

NOTE: Excludes primary regulators, structures for support/heat sinks, and unit rectifiers/filters/regulators/loads (assumed equivalent for both concepts).

voltages and characteristics, and the variation in space available in the units, custom power converter designs will be required for each unit. Experiment ac power requirements will result in dc-ac inverters that can affect volume and, in some cases, thermal design. Although the cost of the chopper, transformer, rectifiers and filters for each small dc-dc converter is less than a large dc-ac inverter, the frequency control, overall design complexity and development costs are comparable. It can be reasonably expected that the requirements for experiment package power supply modifications (one for each package), will result in many times the cost of the dc-ac inverters used in the Spacelab ac power distribution.

Table 4-6 summarizes the comparative costs of the two Spacelab power distribution approaches. Estimated costs are for the total program. As shown by the table, additional costs to install the modifications into the units for the dc concept were not estimated.

4.3.4.3 Conclusions

It was concluded that there is no easy way to eliminate the double conversions that take place in both approaches, short of complete redesign of the equipment for optimum use of source power. This would mean completely redesigned custom units with the attendant cost impact.

The ac power distribution system is the lowest cost approach to accommodate the wide range of CAM equipment studied. The cost of many new dc-dc converter designs, unit modifications, and attendant problems for the 28 vdc primary power distribution system far overshadows the cost of the standard inverters used in the ac distribution system.

Table 4-6. Delta Cost Comparison of AC and DC Power Distribution

	CONVERSION UNIT	ESTIMATED DEV. COST EA. UNIT ($K) *	DEVELOP-MENTS IN PROGRAM	ESTIMATED UNIT COST ($K)	NUMBER OF UNITS IN PROGRAM *	HARDWARE COST ($K)	PROGRAM TOTAL ($K)
AC POWER DISTRIBUTION	3-PHASE, 115/200 VAC, 400 HZ INVERTER: 2.2 KVA	100-150	1	6-7	3	20	145
	115 VAC, 60 HZ INVERTER: 1.0 KVA	75-100	1	5-6	3	17	92
		150	1				
	220 VAC, 50 HZ INVERTER: 2.0 KVA	75-100		5-6	3	17	92
	28 VDC, REGULATED ±2%, DC-DC CONVERTER: 500 WATTS	50-70	1	4-5	3	14	74
	TOTAL						403
DC POWER DISTRIBUTION	DC-DC CONVERSION MOD, 1-3 OUTPUTS	50-70	285	2-3	788	1,970	10,430
	DC-DC CONVERSION MOD, 4-7 OUTPUTS	50-70		5-7	788	4,728	13,188
	TOTAL						23,618 + EXPERIMENT EQUIPMENT MODIFICATION COSTS

*BASED ON 3 SPACELABS, 282 UNIQUE EXPERIMENT ITEMS (1577 TOTAL) PER PROGRAM

5.0 MODIFICATION SOURCE TRADEOFF

The purpose of this tradeoff is to determine the most cost-effective agency to perform equipment modifications. The objectives for the tradeoff are as follows:

1. Recommend source for equipment modifications.

2. Assess the sensitivity of the above recommendation to changes in the assumptions.

5.1 GENERAL APPROACH TO THE TRADEOFF

The following assumptions were used as the basis for conducting this tradeoff:

1. The range of the recommended equipment modifications for the selected equipment items (Section 3.0) is assumed to be representative of all equipment modifications planned for the Spacelab operations.

2. The frequency of Spacelab operations (flights) will be in accordance with the latest NASA Payload Mission Model (October, 1973).

The options considered in this trade include the following:

1. Each equipment manufacturer incorporates modifications to his own equipment.

2. One centralized contractor incorporates modifications to all equipment items.

3. NASA incorporates modifications to all equipment items.

The criteria used for assessing the various options included the following:

1. Cost to do equipment modifications.

2. Time to do equipment modifications.

3. Ability of each organization to incorporate the modifications.

4. Modified equipment performance risk.

5.2 EQUIPMENT MODIFICATION PROCESS FLOWS

In order to evaluate both the cost and time to perform equipment modifications, process flow charts were constructed in a modified PERT format. These flows were constructed to a level sufficient to highlight some of the differences that could occur among the various options. They also become the basis for identifying succinct modification tasks and allocating time spans for accomplishing each task.

Figure 5-1 represents the original equipment manufacturer's modification process flow. The modified PERT format allows time values (days) to be allocated for performing the major modification tasks. These time values are in nominal days, determined from discussions with equipment manufacturers, estimates based on the total number of tasks to be performed, and the general character of each task.

Three methods of accomplishing the equipment modifications by the original manufacturer were identified. Method 1 represents equipment taken from the assembly line at an appropriate stage of buildup, modified, and put back in the assembly line for final assembly and test. Method 2 represents the construction of modified equipment from the initial piece-parts to final assembly and test (separate and distinct from all other on-going manufacturing operations). Method 3 represents the modification of completely assembled equipment taken from the manufacturer's inventory. There is virtually no difference in process duration for any of the three methods presented (considering the restraint of the overall series of tasks to be performed). Methods 1 and 3 show a nominal overall time span of 103 days to accomplish equipment modifications, while Method 2 requires 104 days. However, Method 1 is probably the most cost-effective sequence since it maximizes the use of existing production procedures.

Figure 5-2 depicts the equipment modification process flow for a centralized contractor or the NASA. The total time to accomplish a representative equipment modification is seen to take considerably longer than the original manufacturer (approximately 75 percent longer). The increase in time results mainly from the ordering of the equipment to be modified, waiting for the equipment to arrive, the inspection of the equipment construction to determine the amount of modification required, and waiting for special parts and/or materials which were ordered. The relatively long time assigned to the last item for the NASA is a result of the larger number of items to be procured. It is assumed that the centralized contractor selected to perform equipment modifications will be a broad-range instrument manufacturer who would have more of this material on hand than would the NASA. Conversely, the time required to develop new drawings may be less for the centralized contractor and the NASA because of the learning curve effect brought about by repetition of similar modifications. This advantage, however, may be offset by a lack of familiarity with the equipment.

The actual time to perform the equipment modification (an average of two days) is the same in both process flows because the actual modification task should be equally unfamiliar for all three alternatives.

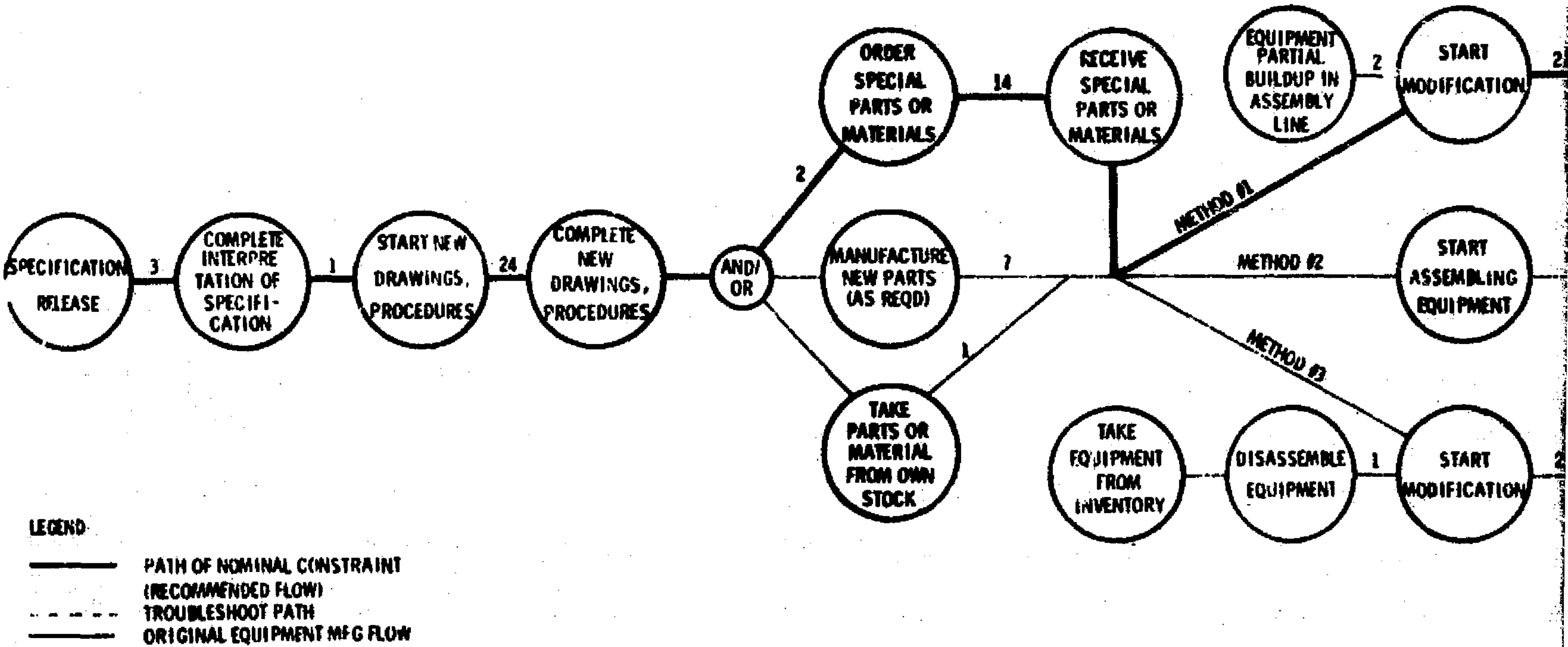
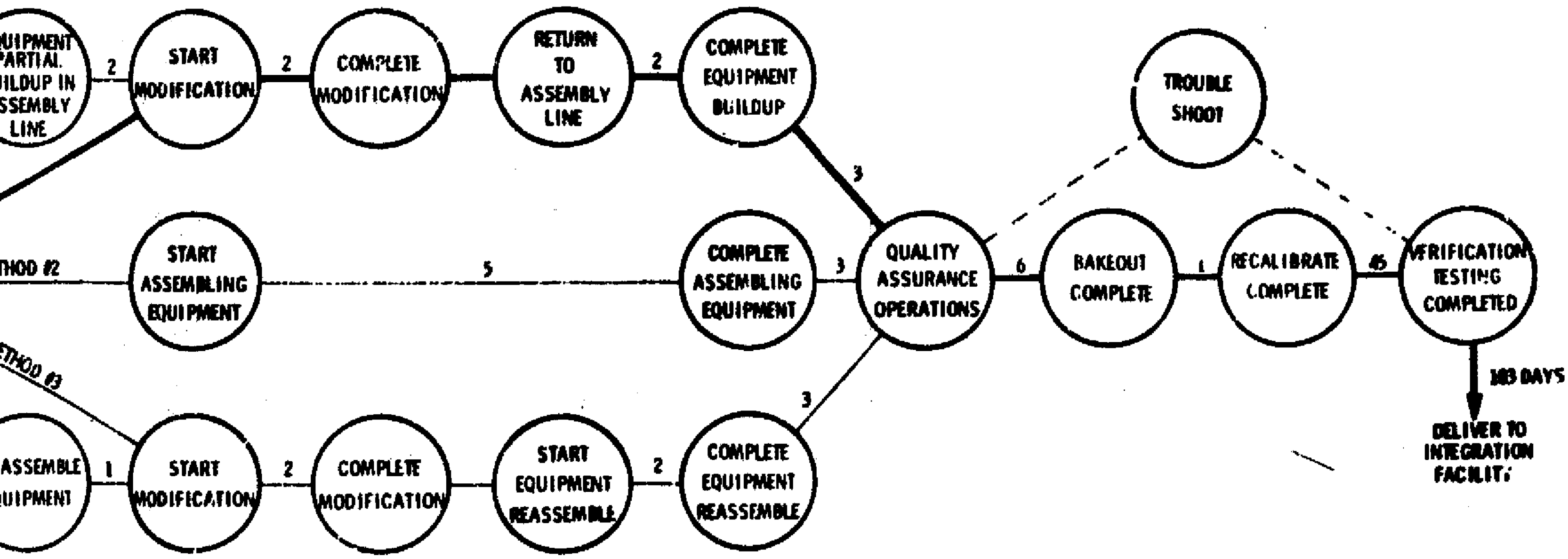


Figure 5-1. Original Equipment Manufacturers' Mod



ent Manufacturers' Modification Process Flow

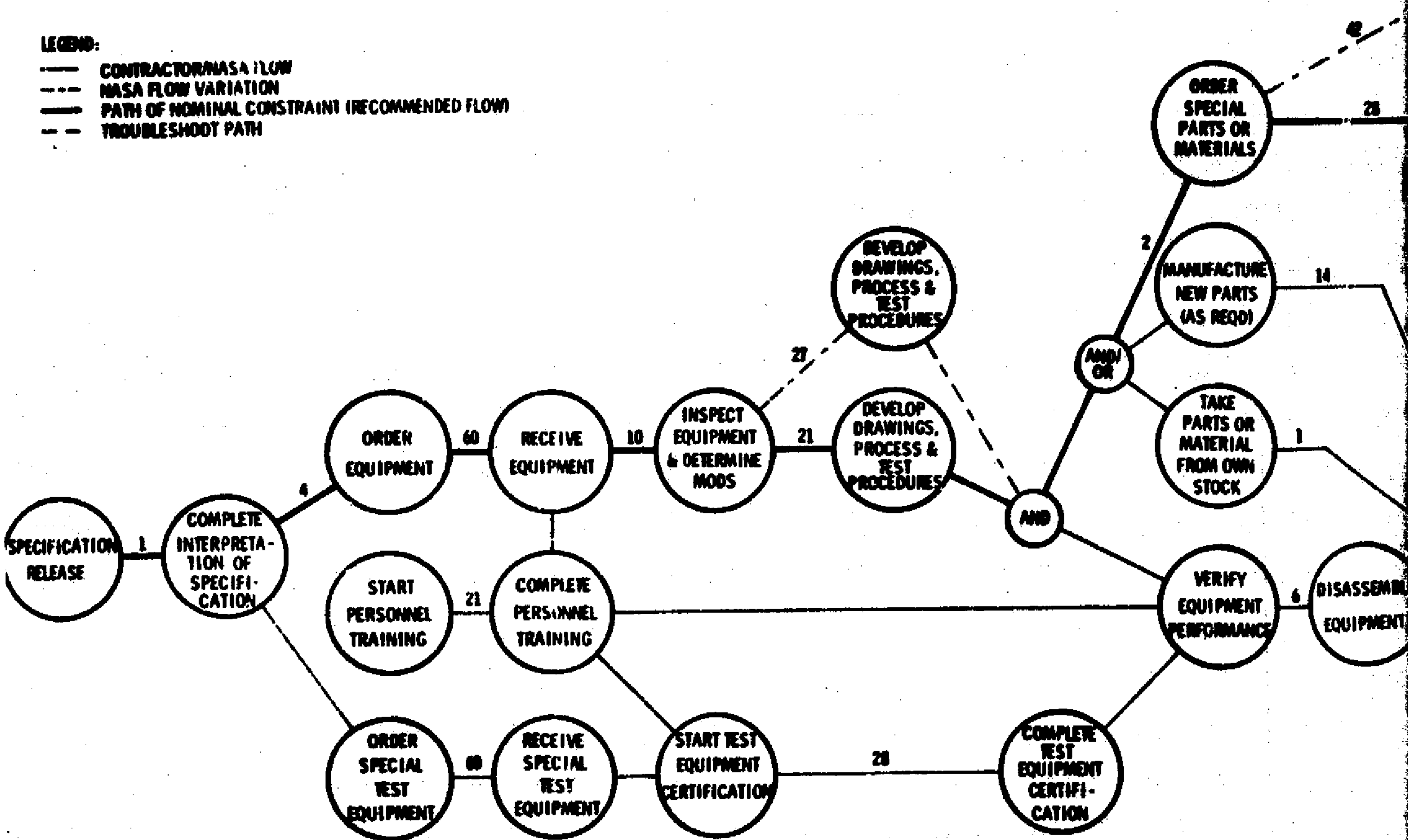


Figure 5-2. Process Flows for Centralized

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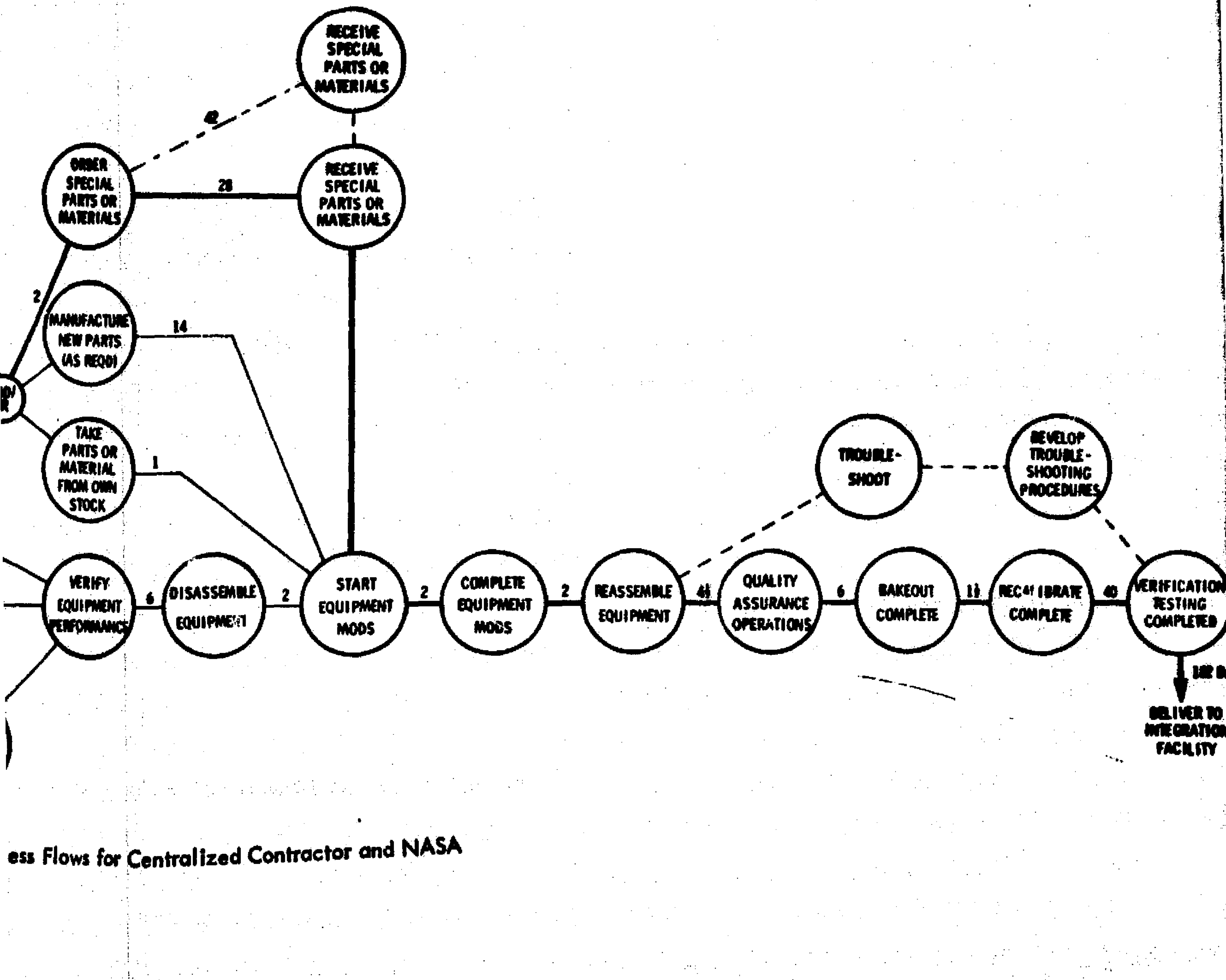

ess Flows for Centralized Contractor and NASA

5.3 FACILITIES AND OTHER RESOURCE REQUIREMENTS

From the equipment modifications recommended in Volume 3, the facilities and other resources required to accomplish the various equipment modifications were determined. A key question to be answered concerned the existence of these resources at each equipment manufacturer and the availability of these facilities to perform the modification tasks. The approach taken to answer this question was a questionnaire mailed to the 25 equipment manufacturers of the items selected for suitability analysis. In addition to a query about resources, the questionnaire also addressed the method of doing the modifications, the willingness of the company to participate in such a modification program, and an indication of minimum quantities of equipment required to initiate the modification activities. Figure 5-3 is a sample of the commercial equipment questionnaire.

The results of the survey are shown in Table 5-1 and summarized as follows:

1. Sixty-eight percent of the questionnaires were answered.

2. All manufacturers who replied were in general agreement that they could undertake the typical equipment modifications (they had the resources). Several cases were identified where changes to vendor-furnished equipment would have to be negotiated.

3. Fifty percent of the companies responding would pull units off the assembly line at an appropriate stage of buildup, modify them, and place the units back in the line for final assembly; 25 percent said they would modify the completely assembled units taken out of inventory; 12-1/2 percent stated that they would special-build the equipment; and 12-1/2 percent failed to answer this question or could not answer it until specific quantities of modified equipment were identified.

4. Eighty-eight percent of all companies responding said they would be willing to perform the equipment modifications; 12 percent said they might be interested.

5. The minimum number of units which would have to be ordered for a company to undertake equipment modifications ranged from 1 to 50--the average being 10 units.

The NASA was also questioned about the facilities and resources available to perform equipment modifications. It was determined that no central facility existed, but rather the capability was widely scattered among the various NASA centers. It was also determined that certain centers probably had excellent experience with specific types of equipment, depending on the kinds of development and operational activity inherent within each center.

COMMERCIAL EQUIPMENT QUESTIONNAIRE

The analysis of commercial equipment and instrumentation for possible use on Shuttle Spacelab payloads has shown that modifications are almost always required. The intent of this questionnaire is to determine the most cost-effective agency to perform these modifications.

1. The following items are typical modifications identified for a wide range of commercial products. Does your plant/division have the capability to modify your equipment in these representative areas?

	YES	NO	REMARKS	
a. Replace PVC insulated wire with Teflon insulated wire.	☐	☐	☐	________
b. Change circuit board and chassis installations to withstand Shuttle vibration environment by adding stiffening members, special holders, clamps, etc.	☐	☐	☐	________
c. Add or enlarge air passages for adequate forced-air ventilation aboard the Spacelab.	☐	☐	☐	________
d. Replace/protect glass with Lexan.	☐	☐	☐	________
e. Contain all shatterables (such as CRTs) within shield housings or equipment case.	☐	☐	☐	________
f. Apply conformal coatings to circuit boards.	☐	☐	☐	________

2. In general, how would you plan to modify your products?

☐ Pull off production line at an appropriate stage of buildup, modify, and put back in line for final assembly steps and test?

☐ Modify the completely assembled unit in a separate area?

☐ Other (Please specify)? ________________________________

____

3. Would you be willing to modify some of your products for use on Shuttle Spacelab payloads?

YES ☐ NO ☐ MAYBE ☐

4. What minimum quantity of equipment would have to be ordered for you to undertake the aforementioned modification activities (please check one)?

1	2	4	8	12	18	25	50

Company ________________

Prepared by ________________

Title ________________

Telephone Number ________________

Figure 5-3. Sample of Commercial Equipment Questionnaire

Table 5-1. Results of Equipment Manufacturer Survey

ITEM	REPLACE PVC INSULATED WIRE WITH TEFLON INSULATED WIRE?	CHANGE CB AND CHASSIS TO WITHSTAND VIBRATION?	ADD OR ENLARGE AIR PASSAGES?	REPLACE/PROTECT GLASS WITH LEXAN?	CONTAIN ALL SHATTERABLES?	APPLY CONFORMAL COATING TO CB?	PULL OFF PRODUCTION LINE, MODIFY, PUT BACK IN LINE?	MODIFY A COMPLETELY ASSEMBLED UNIT?	OTHER?	WILLING TO MODIFY?			MINIMUM ORDER QUANTITY
										YES	NO	MAYBE	
1	YES	YES	YES	NA	NA	YES	X			X			4
2	NO	YES	YES	NO	YES	YES	X			X			25
3	YES	YES	YES	YES	YES	YES	X			X			1
4	YES	YES	YES	YES	YES	YES			SB			X	1
5	YES	YES	YES	NA	NA	YES		X		X			
6	YES	YES	YES	YES	YES	YES	X			X			1
7	YES	YES	YES	YES	YES	YES	X			X			8
8	YES	YES	YES	YES	YES	YES		X		X			1
9	NA	NA	NA	NA	NA	NA							
10	YES	YES	NO	YES	YES	NO	X			X			
11	YES	VP	YES	YES	YES	YES	X			X			1
12	YES	YES	YES	NA	NA	NA			SB	X			1
13	YES	NA	NA	YES	YES	YES	?	?				X	18
14	VP	YES	YES	YES	YES	YES		X				X	25
15	YES	YES	YES	NA	NA	NA	X						
16	YES	YES	YES	NA	NA	YES		X		X			50
17	YES	YES	YES	YES	YES	YES	?	?		X			1

NA NOT APPLICABLE
VP VENDOR PRODUCTS INVOLVED
SB SPECIAL BUILD

In order to more fully explore the possibility of performing equipment modifications right on the assembly line (as a part of the original equipment buildup), two representative commercial facilities were inspected--Beckman Instruments and Hewlett-Packard. In each case, assembly techniques were studied for different types of equipment.

At the Beckman Instruments facility, spectrometers were being individually assembled on a conveyor line. Assembly records traveled with each unit, so special assembly instructions could be accommodated. The most difficult part of the operation would be ensuring proper distribution of custom subassemblies or materials to the various work stations. With sufficient lead time, these procedures could be worked out with little or no impact on the normal assembly operations.

The manufacturing flow of a gas chromatograph was much simpler because these instruments were assembled at a single work station. For this kind of assembly operation, special parts, materials and subassemblies could be kitted for the modified instruments. Accordingly, it is anticipated that any number of custom units could be assembled without significantly affecting the normal production activity.

At the Hewlett-Packard facility, timers, digital counters and receivers were observed during their manufacturing flow. Here again, the single work station per assembled instrument approach was used. This same production technique appears to be quite effective for production rates in the range of 100 to 1200 units per month.

The conclusion reached after studying the manufacturing, assembly, and test operations of several different kinds of instrumentation equipment are twofold. First, it is entirely possible to incorporate modifications as a part of the original equipment buildup. Special parts and/or materials could be distributed to the various work stations along with special instructions. Second, the substitution of Teflon-insulated wire in place of PVC-insulated wire would probably cause the most problems at an original manufacturer's facility. The basic problem is the identification of the new wire so that it would not be mistaken for PVC-insulated wire commonly used in that plant. The current PVC-insulated wire uses many different color codings. The same color combinations could also be used for Teflon-insulated wire. So, rather than assign particular color combinations exclusively for Teflon-insulated wire, a more practical method would be to utilize wire which has the word "Teflon" stamped or printed on the insulation. For this identification method, a solid color (or white) would give the best results.

Should the Teflon-insulated wire inadvertently become mixed with PVC-insulated wire, there are three quick tests (other than the printed word, "Teflon") to determine the differences. These tests are as follows.

1. <u>Touch</u>. Teflon feels slippery, soapy, and is hard to hold between fingers when tension is applied to wire. PVC is easy to hold with fingers.

2. Adhesive. Most adhesives will stick to PVC, but will not stick to Teflon.

3. Flame. Teflon swells and sags but does not burn; PVC burns.

For each of these tests, any nylon sleeving on the PVC-insulated wire should be removed.

5.4 EVALUATION CRITERIA ANALYSIS

In evaluating the various options in terms of the criteria previously established (cost, schedule, ability, and risk), it should be stated that actual modification costs were not available from the original equipment manufacturer. The estimated modification costs that were generated in the study actually represent activities by a centralized contractor or the NASA because they include disassembly, reassembly, recalibration and retest operations. Although these kinds of operations could be performed by an original equipment manufacturer and included in his estimated costs, he would (in all probability) not incur these costs by choosing to modify the equipment during initial build-up (either on the assembly line, adjacent to the assembly line, or at a separate assembly station).

It should also be recognized that for each different category of equipment, the centralized contractor and the NASA must first become familiar with the construction details before specific modifications can be implemented. This learning curve effect is only important when the equipment acquisition rate is very low, in which case the original equipment manufacturer has a distinct time advantage. If the acquisition rate is significantly high, both the centralized contractor and the NASA would soon become familiar with the construction details of each specific item.

5.4.1 Modification Costs

The original equipment manufacturer can incorporate the recommended modifications for less cost than a centralized contractor or the NASA. The next least-cost option appears to be the centralized contractor. The rationale for this decision is based upon two prime considerations.

1. The first consideration is the basic familiarity of a centralized contractor with many types of instrumentation being considered for Spacelab operations. This organization would not take as long as the NASA, for instance, to become familiar with basic construction details, calibration methods, test procedures, and troubleshooting techniques (should they become necessary).

2. The second consideration is the inherent flexibility of personnel to do the various tasks and the high utilization of plant and equipment (low depreciation costs) of an instrument manufacturing company, as compared to the NASA. The company can place personnel performing modifications on other instrumentation fabrication activities,

while NASA does not have parallel fabrication activities to support the excess personnel normally required for peak equipment processing periods.

3. The total number of tasks to accomplish a typical modification is 14 for the original manufacturer and 16 for the centralized contractor and the NASA (see Figures 5-1 and 5-2).

4. The original manufactuer can perform modification cheaper because he does not necessarily incur double costs for disassembly, reassembly, recalibration and retest while a centralized modifier always incurs these costs. The original manufacturer can take a partially completed unit from the assembly line and modify it, while a centralized modifier always starts with a finished product. The following cost details for the PDP-8E Computer have been extracted from Volume III to illustrate this point.

<u>Disassemble</u>	
40 man-hours, manufacturing engineer	
40 man-hours, manufacturing technician	$1280
<u>Reassemble</u>	
20 man-hours, manufacturing engineer	
60 man-hours, manufacturing technician	
40 dollars, material costs	$1283
<u>Retest to Original Specifications</u>	
100 man-hours, test	
40 man-hours, manufacturing engineer	$2095
<u>Other Support for Above Operations</u>	
15 man-hours, assembly	
20 man-hours, inspection	
20 man-hours, manufacturing engineer	
40 man-hours, expedite	$1271
Total modification costs	$5829

The above example reveals that approximately $5800 in additional costs would be incurred for each modified computer if the modifications were incorporated by a centralized contractor or the NASA.

Extending this example of program proportions and assuming the $5800 applies to each of the modified units as an upper limit, the maximum program cost for this function could be as much as $10 million. Also, unique test setups for individual equipment types and the acquisition of special test equipment would incur additional costs for a centralized contractor or the NASA.

Conversely, a centralized contractor or the NASA would, in all probability, be able to buy certain materials in sufficient quantity that considerable cost savings could be realized. This conclusion is based on the total qunatities of acquired equipment (shown on bottom line of Table 5-1).

5.4.2 Modification Time

Original Equipment Manufacturer

The nominal length of time to modify a typical item of equipment, as shown in Figure 5-1, requires approximately 103 days. The path of nominal constraint (and minimum total time) follows either Method 1 or Method 3. Method 1 would modify equipment during the buildup cycle, while Method 3 would take completed items of equipment from the manufacturer's inventory for modification and subsequent testing. The other method (assemble modified equipment completely when all parts are available) does not show an appreciable increase in time to process equipment modifications. One conclusion reached is that the specific method is not a real-time constraint and should be left to the individual manufacturer's choice.

Contractor/NASA

The nominal length of time to modify a typical item of equipment is approximately 182 days (Figure 5-2). The path of nominal constraint (and minimum total time) follows the estimated times shown for the centralized contractor. It should be noted that some of this time (60 days) is spent simply waiting for the equipment to be delivered after an order has been placed. Also, 10 days (average) is required to thoroughly inspect the equipment for construction details and determine the extent of modification required. Once these modification details have been documented for an individual equipment item, the 10 days would not be repeated; but this time period would be required for each new item to be modified.

The variation anticipated for the NASA to do the equipment modification would add about 20 days to the total processing time. The extra time stems from the concept that the NASA is not currently a producer of commercial-type instrumentation equipment and would, therefore, be unfamiliar with the design details, some manufacturing processes, shop instructions, test procedures, material usage, etc., for specific types of instrumentation equipments. The learning curve effect has been discounted to this instance because of the many different types and makes of commercial equipment to be modified.

5.4.3 Modification Ability

Original Equipment Manufacturer

The results of the questionnaire revealed that all companies who responded were equipped with the necessary facilities and resources to do the recommended modifications. The only exception to this conclusion would be in the area of certain environmental test equipment. In those cases where an original equipment manufacturer does not have the necessary environmental test equipment, the tradeoff has assumed that the necessary verification tests would be subcontracted to environmental test laboratories for virtually no additional cost to the program.

Contractor/NASA

Because of the kind of business in which a centralized contractor and/or the NASA is engaged, and their size relative to a typical original equipment manufacturer, it was assumed that both parties would have the necessary facilities and resources. There are two exceptions: (1) personnel trained to work on specific types of equipment, special test equipment and test setups, and (2) a basic stock of certain parts/materials peculiar to an original equipment manufacturer constructing a specialized product line. These shortages can all be overcome in time, but they do represent additional tasks--much more so for the NASA than for a centralized contractor. The centralized contractor would have a distinct advantage because he already has a basic knowledge of certain instrumentation details, trained personnel, and available manufacturing facilities which he can utilize.

On the other hand, the fact that the NASA's facilities are widely scattered makes the acquisition of trained instrument personnel, special test equipment, special test setups, and increased material inventories a costly venture because of the inherent duplication involved. Should a centralized instrumentation facility be justified, the additional cost involved would be a real deterrent.

A factor against both types of centralized instrumentation facilities (Contractor/NASA) is the rate of equipment acquisition. Modified equipment totals developed in Section 4, Volume III have been plotted as shown in Figure 5-4. The significance of this figure is the fluctuating nature of the experiment acquisition totals per year, which reveals a peak every five years. The resulting fluctuation of manpower requirements would present a problem of periodic hiring and firing of personnel or shifting of personnel to perform some other useful tasks. Staffing flexibility available to the centralized instrumentation manufacturer might reduce the impact of these peaks somewhat, as previously discussed.

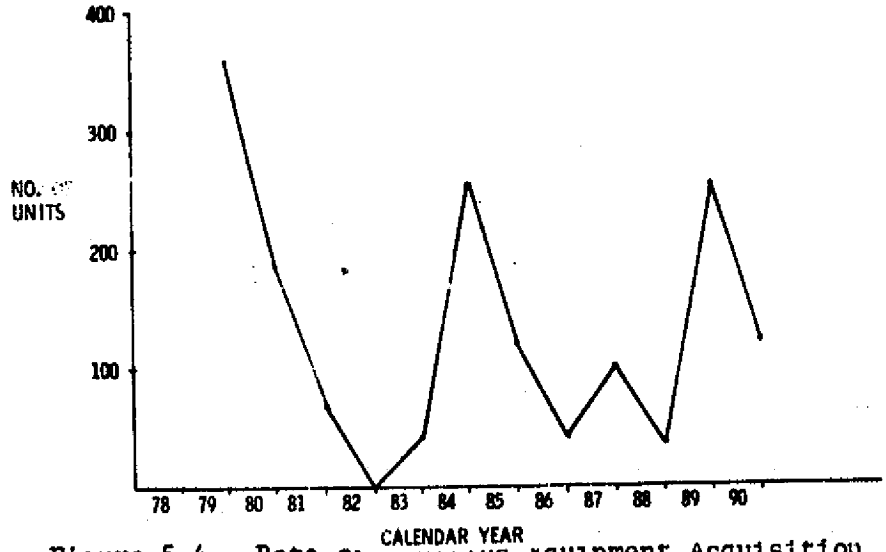

Figure 5-4. Rate of Modified Equipment Acquisition

5.4.4 Modified Equipment Performance Risk

Original Equipment Manufacturer

The original equipment manufacturer appears to be in the best position to warrant the performance of the modified equipment. This conclusion is based upon the typical practice that equipment performance is not warranted if modifications have been performed by the buyer/user. In almost all cases, the original equipment manufacturer will guarantee performance of a modified unit providing he has the opportunity to conduct verification tests on the modified equipment.

Contractor/NASA

Centralized contractors will not normally assume responsibility for equipment that they have not designed, manufactured and tested. Therefore, in the case of modified equipment, we must assume that a centralized contractor will retain the same attitude; i.e., no warranty stated nor implied. This attitude simply points out that the performance guarantee must be assumed by the modified equipment buyer/user. But, this additional responsibility would impose no undue burden, assuming that properly trained technicians and facilities are available to make the equipment work properly and to maintain the equipment. The risk identified here, in terms of equipment performance, must be borne by the buyer/user after the equipment warranty expires. So, in a very real sense, the risk involved is limited to the time period normally covered by the original equipment manufacturer's warranty--normally one year.

5.5 RECOMMENDED APPROACH

A review of Table 5-2 indicates that the original equipment manufacturer is the best choice to accomplish the recommended equipment modifications. This conclusion is based upon the factors of cost, the shortest time to accomplish the modifications, the inherent ability to incorporate the modifications, and the least risk to guaranteed equipment performance. Even without applying weighting factors to each evaluation criterion, Table 5-2 indicates a wide margin between the original equipment manufacturer's rating and the other options considered in this tradeoff. The first recommendation, therefore, is to utilize the original equipment manufacturer for equipment modifications in all cases where practical. It should be recognized, however, that a certain amount of technical coordination will be required with each manufacturer to determine the exact changes to be implemented for each type of equipment purchased.

The above recommendations must be tempered by the willingness of the original equipment manufacturer to make the required modifications. It is conceivable that some high-production companies will not be interested in modifying their product line for just a few items (the average minimum buy is about 10 units). If this is the case, the next best source to perform the equipment modifications would be a centralized contractor. This recommendation is based primarily upon the existing capability and lower cost of a centralized contractor to perform the required equipment modifications, as compared to the NASA.

Table 5-2. Equipment Modification Trade

	Cost	Time	Ability	Responsibility
Each Vendor Does Own Modifications	GOOD High equipment utilization, low depreciation costs Test equipment already available Special test setups already available Less total tasks Flexible personnel	GOOD More time to interpret specification More time to make new drawings Shortest time to do modifications Purchasing response short (have equipment in stock)	GOOD Equipment available Skilled personnel available Procedures available Troubleshooting easy	GOOD Warranty in effect
One Centralized Vendor Does All Modifications	FAIR Additional test equipment required Buy certain materials in large quantities Special test setups required Large number of total tasks	FAIR Less time to interpret specifications (repetition) Less time to make new drawings (repetition) Medium time to do mods. Purchasing response long (number of items	FAIR Equipment must be obtained (part) Skilled personnel not available Procedures not available Troubleshooting difficult	POOR No warranty
NASA Does All Modifications	FAIR Additional test equipment required Buy certain materials in large quantities Special test setups required Large number of total tasks	FAIR Less time to interpret specification (repetition) Less time to make new drawings (repetition) Longest time to do mods. Purchasing response long (number of items)	FAIR Equipment must be obtained (part) Skilled personnel not available Procedures not available Troubleshooting hard	POOR No warranty

Another factor to be considered, however, is the benefit to be expected from a centralized facility for certain common modification operations such as conformal coating application and verification testing (vibration, EMI, and thermal environments). These items would appear to benefit from a centralized facility because of the better quality control (conformal coatings) and a more uniform application of common environments (vibration, thermal) and EMI. Because the benefits of a centralized facility are seen to be intangible, it is difficult to precisely evaluate the degree of improvement which might be expected. Here again, the effect of the equipment acquisition rate is seen to be a negative factor because the fluctuation between high and low extremes would tend to make the operation of a centralized facility quite inefficient. Further study is required to determine whether outside vending of these activities is more cost effective than the buildup of a dedicated facility.

6.0 EQUIPMENT RECOMMENDED FOR PROCUREMENT

Adoption of a policy endorsing the purchase of CAM equipment for Spacelab experiments cannot be based solely upon analytical data. Many of the conclusions drawn during this study require physical validation by testing. NASA-MSFC currently plans to procure certain CAM items to supplement the results of this study providing information for the CAM equipment-use decision. This section presents the items recommended by the study team for procurement.

6.1 CHARACTERISTICS OF EQUIPMENT SELECTED FOR PROCUREMENT

Procurement recommendations are based upon the results of the analysis of 34 selected equipment items, and the study team's understanding of actions taken on two related programs, the Spacelab and the Beckman study, "Analysis of Multipurpose Equipment for Space Applications." In selecting specific items for recommended procurement and test, the following factors were considered:

1. Cost-Effectiveness. The equipment recommended for procurement and test can be cost-effectively modified for suitability in the Spacelab.

2. Frequency of Use. The number of equipment types required by the sortie experiment program, identified in Section 4.1 (Volume III), was reviewed to assure that the equipment recommended for procurement is that which is truly useful to the sortie experiment program, is representative of a broad range of discipline requirements, and accounts for a significant proportion of payload funding requirements.

3. Resolution of Issues for Further Analysis. Equipment items were identified which, if procured and tested, will help resolve the suitability of characteristics which could not be verified during the suitability analysis.

4. Design, Materials, and Processing Differences. Units were selected so that differences due to variations in specifications and construction practices can be assessed. Differences among standard commercial, aircraft, and military hardware must be represented by the selected hardware list.

5. Functional Diversity. It will also likely be useful to procure and test a variety of types of items: electronic (e.g., amplifiers), electro-optical (e.g., lasers, spectrophotometers), electromechanical (e.g., tape recorders), chemical (e.g, gas chromatographs, pH meters) to understand construction differences among hardware types.

6. Modification Feasibility Verification. All items recommended require some modification. The modification activity will physically illustrate and verify study findings.

6.2 TECHNICAL ASSESSMENT OF EQUIPMENT TYPES

Equipment types examined during the study are listed on Table 6-1 in order of preference for procurement on the basis of the technical merit of testing these units. This list reflects the opinion of the study team as to which equipment items would yield the most information when tested. In many cases the type of unit defines the issues that will be examined by testing. For these units, a "no preference" comment has been placed in the Manufacturer column. Obviously, the best correlation with study results will occur if the same unit analyzed is also purchased for testing. When the unit of a manufacturer displays specific characteristics meriting testing, that manufacturer has been identified. For example, the Nuclear Data spectrum analyzer is not only constructed according to NIM packaging specifications, but its wire connections are wire-wrap type instead of the typical solder connections. To assure that both wire-wrap and solder-type connections are tested, a specific selection was made.

The items listed have been grouped into three categories. The first category, Units of Significant Interest, include those items with diverse characteristics yet representative of the hardware that could be placed in the Spacelab. Units with similar characteristics are not repeated. The second group includes items which have characteristics similar to the units in the first group, or items which are expected to have limited use in the Spacelab. For example, many of the electronic packages fall into this category because the computer and the strip chart recorder were selected as more desirable units and placed in the top group. Finally, the three units that could not be cost-effectively modified for installation in the Spacelab were placed in a separate category. These units are excluded from consideration. The characteristics that make the unit interesting and/or the reasoning behind placement of the unit in a given category are stated in the Rationale column.

6.3 PRELIMINARY EQUIPMENT-TYPE ASSESSMENT

Equipment types were assessed for possible procurement based upon potential programmatic savings and the availability of equipment and information from other studies.

The analyzed equipment types were ranked by potential savings to the Spacelab experiment program. The 21 types represented by the 31 units that could be cost-effectively modified are ranked in order of highest to lowest savings to the program in Table 6-2. The magnitude of the savings was determined by multiplying the quantity of hardware estimated for the Spacelab experiment program by the estimated first-unit cost savings. The dewar, refrigerator, and Coulter counter were not included on this list because each unit could not be used in its available configuration, even if modified. It has to be custom-built and is, therefore, out of the scope of the proposed test program.

Table 6-1. Equipment Listed by Technical Importance

Type	Manufacturer/Model No.	Rationale
UNITS OF SIGNIFICANT INTEREST		
Tape Recorder	AMPEX, AR700	Airborne unit, was modified and used on Skylab
Spectrophotometer	No preference	Sensitive lab instrument, gravity-dependent junction
Laser	No preference	Glass components, exacting alignment requirements
Computer	No preference	Typical electronic equipment-type construction
Receiver/Transceiver	Collins, 618M-2	ATR packaging airborne qualification; does not overheat up to 55,000 ft (1.68 km) altitude
Spectrum Analyzer	Nuclear Data, 100	NIM packaging, maximum use of integrated circuits; wire-wrap connections
Strip Chart Recorder	Honeywell, 1856	Electromechanical; CRT containment required; design compatible with zero g--no galvanometer, no ink pen
Oscilloscope	Hewlett-Packard AN/USM-281A	Mil-Spec oscilloscope qualified for field use
Microscope	No preference	Optical unit; addresses glass containment issue for unit that can only be made of glass
Gas Chromatograph	Beckman, 6700	Process-type unit; chemical analysis hardware
Digital Voltmeter	Fluke, 8125	Ruggedized Mil-Spec unit; provides for comparison of Mil-Spec designs
Furnace	Astro, 1000 A	Heavy mechanical unit; touch-temperature problems; water cooled
Centrifuge	No preference	Electric motor with potential EMI problem
UNITS OF INTEREST IF SOME OF ABOVE ARE NOT CHOSEN		
Oscilloscope	Tektronix	Typical electronic instrumentation ; sensitive circuits; unit is basic type of laboratory equipment
Digital Voltmeter	No preference	Typical electronic instrumentation; sensitive circuits; unit is basic type of laboratory equipment
Assorted NIM Equipment	Tennelec or Ortec	Typical NIM-type hardware
Electrophoresis Apparatus	No preference	Unit has unique characteristics: gravity-dependent design; high voltages; gravity-dependent batch-type process
Spectrum Analyzer	Fluke 645M or Singer SSB	Mil-Spec electronic units; characteristics already examined by previously identified Mil-Spec electronics
Receiver	No preference	Many airborne and Mil-Spec units available; characteristics examined by Collins unit
Tape Recorder	Honeywell 5600	Portable tape recorder; construction typical of high-quality electronic units
pH Meter	No preference	Simple electronic device; gravity-dependent measurement easily replaced by forced-flow technique
Spectrum Analyzer	Hewlett-Packard	Typical of commercial-type electronics
Amplifer	Neff	Typical of commercial-type electronics
Display Terminal	Research Inc.	Typical of commercial-type electronics; poor suitability for Spacelab use

Table 6-1. Equipment Listed By Technical Importance (Cont)

Type	Manufacturer/Model No.	Rationale
Timer	No preference	Typical of commercial-type electronics
Microtome	Americal Optical, 820	Unit is interesting mechanical unit with major safety and operational problem; downgraded because it is no longer identified as needed for the life science sortie mission
Power Supply	Power Designs	NIM bin power supply; typical electronics; need is dependent on Spacelab power supply
Power Supply	Sorenson	Typical of commercial-type electronics
UNITS WHICH CANNOT BE COST EFFECTIVELY MODIFIED FROM AVAILABLE EQUIPMENT		
Dewar	No preference	Two-phase fluid containment requires new development
Refrigerator	No preference	Zero-g refrigeration cycle requires new development
Blood Cell Counter	Coulter	Totally gravity-dependent with hazardous design for Spacelab environment

The dewar, the refrigerator, and the Coulter counter were not included on this list because each unit could not be used in its available configuration even if it were modified. It has to be custom built and is, therefore, out of the scope of the proposed test program.

Table 6-2. Equipment Types Ranked According to Spacelab Experiment Program Savings

Spectrophotometer
Spectrum/Wave Analyzer
Receiver/Transmitter
Gas Chromatograph
Keyboard Display Terminal
Strip Chart Recorder
Tape Recorder
Furnace
Oscilloscope
Computer
Laser
Particle Counter
Timer
Electrophoresis Apparatus
Amplifier
Microscope
pH Meter
Digital Voltmeter
Power Supply
Centrifuge
Microtome

Table 6-2 was screened; items were eliminated from consideration for the following reasons.

1. MSFC has already obtained the unit from the Beckman study and need not procure an additional item.

2. Current Spacelab documentation indicates that the unit will be included as part of the Spacelab. Therefore, the Europeans will be testing this hardware and MSFC need not expend their funds for duplicate testing.

3. The unit is similar to previously selected hardware. Test data for this item would add little information to the previously selected unit.

4. Few of the given type of equipment are required by Spacelab experiment payloads.

Table 6-3 lists each item and indicates which of the rejection reasons justified elimination of that item.

Table 6-3. Equipment-Type Rejection Rationale

Item	Rationale
~~Spectrophotometer~~	Beckman study equipment
Spectrum/Wave Analyzer	
Receiver/Transmitter	
Gas Chromatograph	
~~Keyboard Display Terminal~~	Spacelab core hardware
Strip Chart Recorder	
~~Tape Recorder~~	Spacelab core hardware
Furnace	
~~Oscilloscope~~	Beckman study equipment
~~Computer~~	Spacelab core hardware
Laser	
~~Particle Counter~~	Represented by spectrum analyzer
~~Timer~~	Spacelab core hardware
~~Electrophoresis Apparatus~~	Major zero-g development
~~Amplifier~~	Spacelab core hardware
~~Microscope~~	Issues represented by laser
~~pH Meter~~	Zero-g development, low savings
~~Digital Voltmeter~~	Beckman study equipment
~~Power Supply~~	Spacelab core hardware
~~Centrifuge~~	Low program savings
~~Microtome~~	Low program savings

6.4 PROCUREMENT RECOMMENDATIONS

The final equipment selection recommendations are presented in Table 6-4. Equipment type, manufacturer, issues represented, the predicted magnitude of the first-unit savings and the quantity of each type of hardware predicted for the Spacelab program are shown for each selection.

Table 6-4. Procurement Recommendations

TYPE	MANUFACTURER	ISSUES REPRESENTED	FIRST-UNIT SAVINGS ($1000)	QUANTITY
SPECTRUM ANALYZER	NUCLEAR DATA	NIM PACKAGING WIRE-WRAP CONNECTIONS	415-540	58
RECEIVER	COLLINS	AIRBORNE EQUIPMENT	150-240	82
GAS CHROMATOGRAPH	BECKMAN	PROCESS-TYPE INSTRUMENTATION CHEMICAL ANALYSIS HARDWARE	355	55
STRIP CHART RECORDER	HONEYWELL	FIBEROPTICS, PAPER WELL SUITED TO SPACELAB	335	58
FURNACE	ASTRO	HIGH TEMPERATURE WATER COOLING	425	20
LASER	NO PREFERENCE	FRAGILE OPTICS SENSITIVE ALIGNMENT PROBLEMS	135	39
OSCILLOSCOPE	HEWLETT-PACKARD	MIL-SPEC DESIGN (ARMY FIELD USE) COMPARISON WITH COMMERCIAL TEKTRONIX	115-290	26
DIGITAL VOLTMETER	FLUKE	MIL-SPEC DESIGN (SUBMARINE) COMPARISON WITH COMMERCIAL FLUKE	17-25	21

The list represents a composite of the cost effectiveness and technical comparisons. Units of significant interest on Table 6-1 were selected if they were not eliminated by the rationale described in Table 6-3. This approach placed emphasis on defining selections which maximized the information return for as low a cost as possible.

The top six units are the units selected by the analysis in Section 6.2. Review of the characteristics represented by these units indicated that no Mil-Spec units had been selected. Therefore, two additional units were included to provide such representation.

Two Mil-Spec units were selected rather than one for the following reasons:

1. Each unit is representative of a different class of military specification. One unit is built for army field use, while the other is built for submarine use.
2. MSFC already has commercial counterparts to these units and the results of comparative testing should be very informative.

3. These units are typically found in all laboratories so they merit having some additional samples for testing.

Manufacturers identified are the same as those examined during the study so that correlation of test and analytical results can be obtained. The laser is the only exception. In the opinion of the study team, similar conclusions can be obtained from testing of cheaper units than the $10,000 Sylvania CO_2 laser examined during the study.

The list of issues represented shows that selected hardware satisfies the goals of the originally defined objectives. All units require some modification. It is strongly recommended that these modifications be accomplished prior to testing. A test program without hardware modification will not verify the study conclusions. The most complete test program would purchase two units. One would be modified and the other left unmodified. Both units would then be subjected to the same testing program to verify the effectiveness of the modification program. If funding is not available for two sets of equipment, then modified hardware should be tested.

7.0 PROGRAMMATIC SAVINGS

Sections 3.0 and 4.0 indicated that it is cost-effective to modify commercially available equipment and instrumentation rather than procuring custom-built hardware. This section discusses the potential savings that could accrue to the entire sortie experiment program if the savings on the selected equipment items are extended to the program level. All extensions apply to the segment of experiment equipment installed on the Spacelab which does not require functional modification.

7.1 PROGRAMMATIC EXTENSION SCENARIOS

The extension of specific equipment costs to the program level is dependent upon the scenario assumed for experiment equipment development and replacement. Dependence on hardware developed in other manned spacecraft programs could reduce the cost of custom-built hardware significantly. If, on the other hand, Spacelab experiment hardware and supporting equipment requirements are unique relative to other space programs, new developments will be required escalating the total cost of the experiment program. Equipment replacement rates establish the number of sets of equipment required by the program. An infrequent rate of equipment replacement would reduce total equipment costs. The definition of new laboratories during the "Shuttle Era" would affect both the equipment replacement rate and number of new developments required for the program.

Figure 7-1 illustrates the scenarios analyzed during the study. Two extremes of development commonality were assessed. Maximum commonality, and therefore fewer new developments, with other Space Transportation System (STS) hardware was examined. The other extreme is represented by examining the cost of all experiment equipment if each equipment type required a new development. This latter case is unrealistic, but it indicates an upper limit on the savings that could be achieved by using CAM equipment instead of custom-built hardware.

Replacement rate alternatives are also shown on the figure. The five-year-life study guideline for replacement of equipment was applied in both cases. Exceptions were made for a few equipment items which either have not experienced rapid technological change historically, or would not provide increased experiment benefits if improved items were used. The microtome is an example of a unit that has not experienced rapid technological changes. Its current design is essentially the same as the design originally developed in 190?. Certain support equipment not directly related to experiment equipment may not need replacement if increased performance requirements do not change. Power and weight considerations may, however, still dictate change-out of these units if lighter weight, lower powered units should be developed.

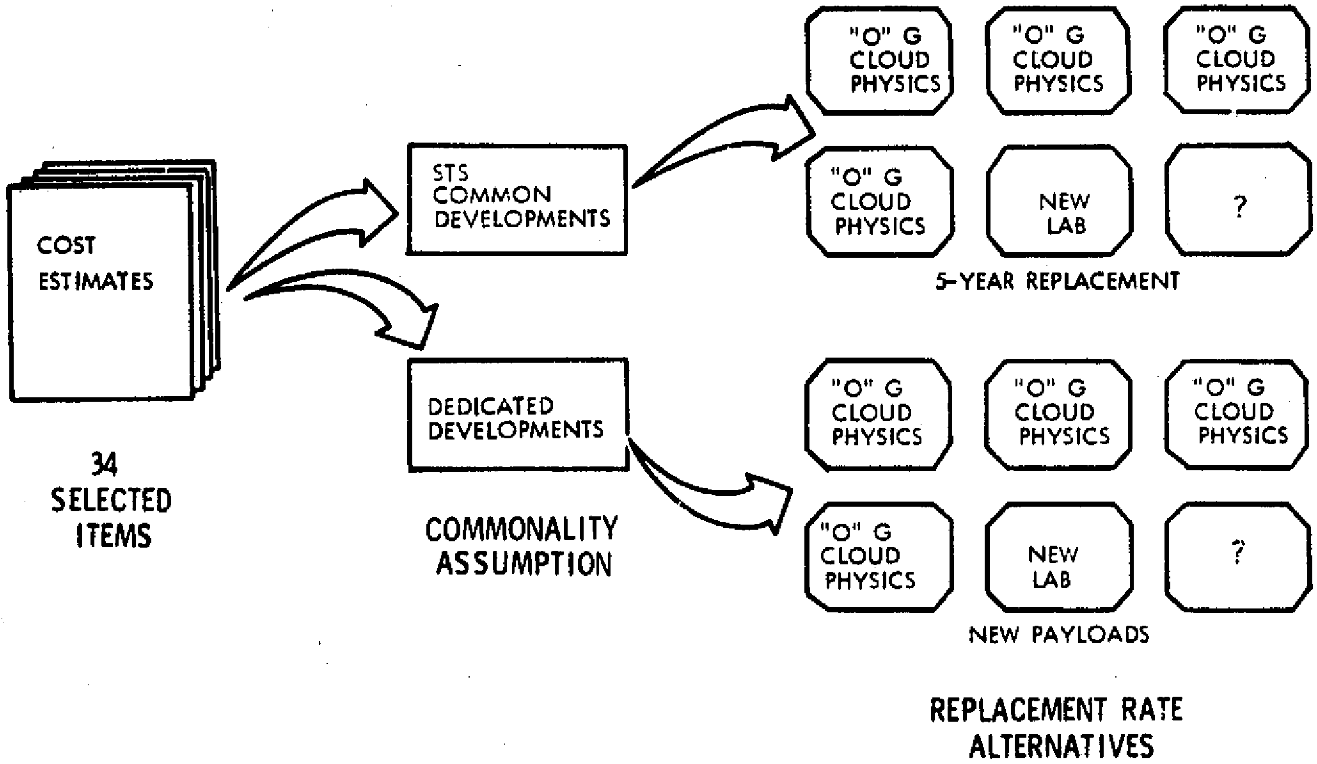

Figure 7-1. Programmatic Extension Scenarios

The study is based upon the payloads currently defined for the Spacelab. New laboratories will most probably be identified within the next few years, and most certainly will occur when the sortie experiment program gathers momentum in the 1980's. The Zero-G Cloud Physics Laboratory cannot be the only earth observations sortie laboratory. Also, the equipment complements identified for the currently defined payloads will change as Spacelab operations progress. The second replacement rate scenario assumes that a new equipment complement will be identified for each discipline every five years, either in the form of an entirely new laboratory or changeover of an existing laboratory.

7.2 SAVINGS PROJECTIONS

Projections of custom and modified equipment costs were based upon the relationship of all equipment identified in the functional requirements data bank that do not require functional modification to the selected equipment items. These relationships are explained in Section 4.0 of Volume III. The quantities identified for each equipment type were grouped with the selected equipment item that it most closely resembled. The modification and custom costs associated with each selected item were assumed to apply to all items similar to it. Total costs were arrived at by multiplying the total number of similar equipment types by the custom and modification costs associated with the related, selected equipment item.

The total cost for a given equipment type included the development costs associated with each unit having different functional requirements and the recurring cost of the repeated procurements of the same hardware. Development costs for the custom and modified hardware are shown in Section 3.0 of this

volume. Recurring costs for each custom-built unit were estimated, based upon the relationships of development and recurring cost CER's (explained in Figure 3-31). These costs were adjusted by assuming manufacturing lot sizes consistent with equipment quantity needs of the program. The cost of each lot was reduced to reflect learning curve affects. Recurring costs for modified hardware included all fabrication costs, but only included 25 percent of estimated engineering and documentation costs to provide for changes occurring in available hardware over the years. Custom-built hardware designs were assumed not to change when repeat sets of equipment were required. Available hardware can take advantage of technology changes without impacting costs, while custom-built hardware would have to be redesigned, incurring additional development costs. Conversely, custom-built hardware could be designed for a longer lifetime than five years providing some programmatic savings by reducing recurring costs.

All modification costs assumed application of the SEEIR specification for equipment modification. Modified hardware costs would be higher by a factor of 2 if the EC006 specification had been used. The total cost of modified hardware would be $42.4 million if only one set of new developments is required, and $68 million if a new development is required every five years if this specification were in force. A slight reduction in the programmatic savings would result from the use of these modified hardware costs.

Figure 7-2 shows the equipment cost expenditures by year for each of the scenarios. All costs are assumed to occur in the year prior to the year the equipment is scheduled to fly. The areas under each curve yield the total programmatic cost. All costs are in 1974 dollars. If the costs were in actual dollars, the savings would be much higher. The higher funding costs in 1979 and 1980 on Figure 7-2 (a) and (b) result from initial hardware development. These peaks could be impacted by funding needs of the Shuttle program. The peaks could be lowered if the hardware development were spread out over two or three years rather than occurring in the year prior to flight. Lower funding in subsequent years results from only incurring recurring-type costs after the initial development. No funding is required in 1982 because no equipment is needed in 1983, assuming the five-year replacement guideline.

Figure 7-2 (a) and (b) depicts the funding requirements if no new payloads or equipment complements occur throughout the program. The $230 million saved is the lowest possible savings that could result from the use of CAM equipment rather than custom-built equipment. This savings increases to $510 million if unique developments are required for all Spacelab experiment equipment and instrumentation.

Figure 7-2 (c) and (d) reflects the programmatic savings if new payloads or equipment complements are needed every five years. It is believed that the nearly $400 million savings shown on (c) is closest to the real world. The savings of $1.2 billion shown in (d) is an extreme case and very unlikely. It is shown only to provide an upper limit on the savings that could be generated. This cost indicates that every effort to use already-developed hardware should be made to lower Spacelab experiment costs.

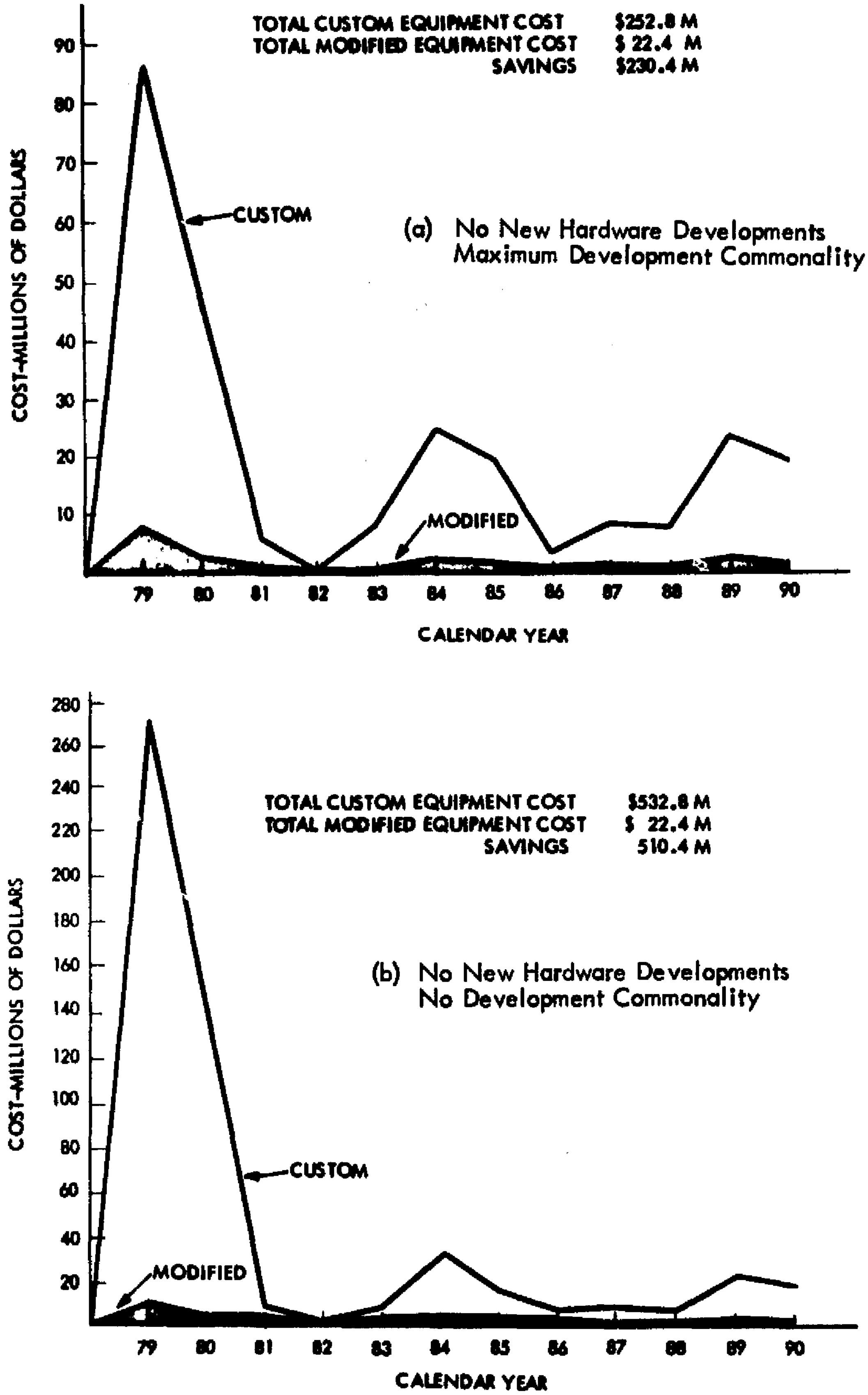

Figure 7-2. Programmatic Cost Comparison

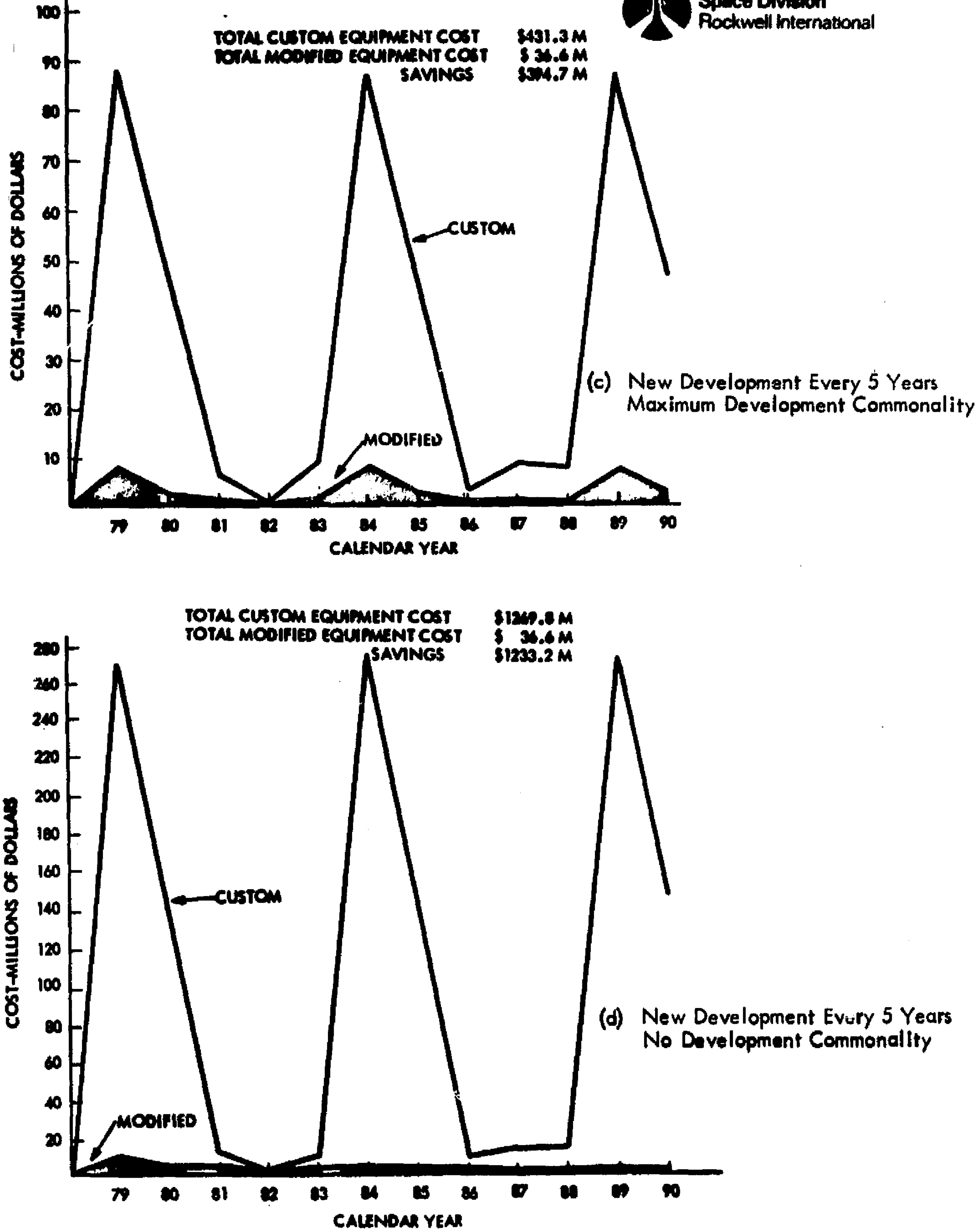

Figure 7-2. Programmatic Cost Comparison (Cont)

8.0 CONCLUSIONS

The following major conclusions were arrived at during this study.

1. The use of commercially available equipment in the Spacelab is both fea ble and cost-effective. Sortie experiment program savings achieved by the use of CAM experiment equipment are between $230 million and $1230 million in 1974 dollars. These savings are dependent upon the development commonality and the equipment replacement rates assumed. The most realistic scenario indicates a savings of approximately $400 million. Further savings may be achieved by using available equipment for pallet-mounted experiments.

2. Between 55 and 65 percent of the equipment defined by all the recent Shuttle sortie payload studies can be accommodated by CAM equipment without functional modification. A more extensive search of supplier data may increase this percentage. The cost savings reported in this study apply only to the equipment items that do not require functional modification. If this quantity of equipment were increased, greater programmatic savings would result.

3. Modifications to a specification compatible with the use of commercial equipment will add approximately 4 to 8 times the retail cost to each item. Modification to a typical aerospace specification will add from 10 to 18 times the retail cost to the item. However, custom-built hardware is an average of 36 times as expensive as the CAM unit. Therefore, no matter which specification is in effect, it is cheaper to used modified available hardware. These savings occur because the functional aspects of the hardware do not have to be redeveloped to be within a compact envelope, meet a minimum weight or power target, or be compatible with a different power form than used in its original design.

4. A specification compatible with the use of commercial equipment can be written which is cost-effective as well as technically sound and compatible with crew safety requirements. The use of commercially available hardware obviates the need for many typical specification requirements which are formulated because order lot sizes are small (such as configuration control on replacement parts). Also, CAM equipment has prior operational experience, reducing the need for performance verification testing and reporting.

5. The most cost-effective modifier of the equipment to Spacelab specifications is the original manufacturer of each item. His knowledge of his own equipment and its immediate availability from inventory, make the original supplier both a cost-effective and timely modifier of his equipment.

APPENDIX A

EXPERIMENT EQUIPMENT FUNCTIONAL REQUIREMENTS LISTED BY SCIENCE AND TECHNOLOGY DISCIPLINE

ASTRONOMY

DISPLAY CRT (CONTROL/DISPLAY CONSOLE) ASO01 21111

PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.

SCREEN SIZE .... 14 IN (0.355 M)

SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE) ASO02 11111

PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT

CHANNELS 2
FORMAT .... VIDEO AND DATA
VIDEO INPUT PRESENTATION ..... RASTER SCAN
SYMBOL WRITING TECHNIQUE ..... STROKE
INTERFACE DESCRIPTION .... DIGITAL-12-BIT DATAWORD

FUNCTION KEYBOARD ASO03 11111

ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY, FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.

KEYBOARD .... TYPEWRITER TYPE
INTERFACE DESCRIPTION .... DIGITAL-32-BIT WORD

ALPHANUMERIC KEYBOARD ASO04 11111

ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR EXPERIMENT CONTROL AND DATA ANALYSIS.

KEYBOARD .... TYPEWRITER TYPE
INTERFACE DESCRIPTION .... DIGITAL-32-BIT WORD

MICROFILM VIEWER ASO05 11111

PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES, SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.

FILM FORMAT .... 16 MM DUAL TRACK
FILM LOADING .... CASETTE
FILM SLEWING .... MANUAL AND COMPUTER SELECT
INTERFACE DESCRIPTION .... DIGITAL 13-BIT BINARY

TIMER - EVENT ASO06 11111

DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE START AND STOP COMMANDS (MINUTES AND SECONDS).

DISPLAY .... 4 DIGITS
DISPLAY TYPE .... LED

TIMER - MISSION ASO07 11111

PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE, SECOND.

DISPLAY .... 7 DIGITS BCD
DISPLAY TYPE .... LED

CONTROLLER, THREE-AXIS HAND ASO08 11132

THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT POINTING AND INITIAL TARGET ACQUISITION.

CONTROLLED AXES 3

CIRCUIT BREAKER/DISTRIBUTOR PANEL ASO09 11131

CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.

CIRCUIT BREAKERS 18
POWER CAPABILITY .... 10 AMPS

INDICATORS-CAUTION AND WARNING ASO10 11132

A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.

INDICATORS 40
.... MASTER ALARM MEMORY
.... POWER/TEST CONTROLS

RECORDER-TAPE ASO11 11111

RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND DISPLAY CONSOLE.

BANDWIDTH .... DC TO 200 KHZ
CHANNELS 14
TIME MARKS .... EDGE TRACK
RECORDED FORMAT .... DIGITAL

ANNUNCIATORS-ADVISORY ASO12 21132

DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.

ANNUNCIATOR-VISUAL .... 12 IN DUAL BANKS
DISPLAY TYPE .... RED, WHITE, GREEN
ANNUNCIATOR-AUDIO .... NONE

ORIGINAL PAGE IS
OF POOR QUALITY

HIGH ENERGY PHYSICS

DISPLAY CRT (CONTROL/DISPLAY CONSOLE) HE001 21111

PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.

SCREEN SIZE .... 14 IN (0.355 M)

SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE) HE002 11111

PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT

CHANNELS 2
FORMAT .... VIDEO AND DATA
VIDEO INPUT PRESENTATION ...... RASTER SCAN

SYMBOL WRITING TECHNIQUE ...... STROKE
INTERFACE DESCRIPTION .... DIGITAL-12-BIT DATAWORD

FUNCTION KEYBOARD HE003 11111

ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY, FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.

KEYBOARD .... TYPEWRITER TYPE
INTERFACE DESCRIPTION .... DIGITAL-32-BIT WORD

ALPHANUMERIC KEYBOARD HE004 11111

ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR EXPERIMENT CONTROL AND DATA ANALYSIS.

KEYBOARD .... TYPEWRITER TYPE
INTERFACE DESCRIPTION .... DIGITAL-32-BIT WORD

MICROFILM VIEWER HE005 11111

PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUBSYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES, SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.

FILM FORMAT .... 16 MM DUAL TRACK
FILM LOADING .... CASETTE
FILM SLEWING .... MANUAL AND COMPUTER SELECT
INTERFACE DESCRIPTION .... DIGITAL 13-BIT BINARY

TIMER - EVENT HE006 11111

DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE START AND STOP COMMANDS (MINUTES AND SECONDS).

DISPLAY .... 4 DIGITS
DISPLAY TYPE .... LED
INTERFACE .... DISCRETE

TIMER - MISSION HE007 11111

PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UPDATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY, HOUR, MINUTE, SECOND.

DISPLAY .... 7 DIGITS BCD
DISPLAY TYPE .... LED

CONTROLLER, THREE-AXIS HAND HE008 11132

THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT POINTING AND INITIAL TARGET ACQUISITION.

CONTROLLED AXES 3

CIRCUIT BREAKER/DISTRIBUTOR PANEL HE009 11131

CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO THESE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.

CIRCUIT BREAKERS 18
POWER CAPABILITY .... 10 AMPS

INDICATORS-CAUTION AND WARNING HE010 11132

A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.

INDICATORS 40
.... MASTER ALARM MEMORY
.... POWER/TEST CONTROLS

RECORDER-TAPE HE011 11111

RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND DISPLAY CONSOLE.

BANDWIDTH .... DC TO 200 KHZ
CHANNELS 14
TIME MARKS .... EDGE TRACK
RECORDED FORMAT .... DIGITAL

ANNUNCIATORS-ADVISORY HE012 21132

DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.

ANNUNCIATOR-VISUAL .... 12 IN DUAL BANKS
DISPLAY TYPE .... RED, WHITE, GREEN
ANNUNCIATOR-AUDIO .... NONE

SOLAR PHYSICS

DISPLAY CRT (CONTROL/DISPLAY CONSOLE) SC001 21111

PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.

SCREEN SIZE .... 14 IN (0.355 M)

SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE) SC002 11111

PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT

CHANNELS 1
FORMAT .... VIDEO AND DATA
VIDEO INPUT PRESENTATION ...... RASTER SCAN
SYMBOL WRITING TECHNIQUE ...... STROKE
INTERFACE DESCRIPTION .... DIGITAL-12-BIT [illegible]

FUNCTION KEYBOARD SC003 11111

ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY, FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.

KEYBOARD .... TYPEWRITER TYPE
INTERFACE DESCRIPTION .... DIGITAL-32-BIT WORD

ALPHANUMERIC KEYBOARD SC004 11111

ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR EXPERIMENT CONTROL AND DATA ANALYSIS.

KEYBOARD .... TYPEWRITER TYPE
INTERFACE DESCRIPTION .... DIGITAL-32-BIT WORD

MICROFILM VIEWER SC005 11111

PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUBSYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES, SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.

FILM FORMAT .... 16 MM DUAL TRACK
FILM LOADING .... CASETTE
FILM SLEWING .... MANUAL AND COMPUTER SELECT
INTERFACE DESCRIPTION .... DIGITAL 13-BIT BINARY

TIMER - EVENT SC006 11111

DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE START AND STOP COMMANDS (MINUTES AND SECONDS).

DISPLAY .... 4 DIGITS
DISPLAY TYPE .... LED

TIMER - MISSION SC007 11111

PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UPDATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY, HOUR, MINUTE, SECOND.

DISPLAY .... 7 DIGITS BCD
DISPLAY TYPE .... LED

CONTROLLER, THREE-AXIS HAND SC008 11132

THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT POINTING AND INITIAL TARGET ACQUISITION.

CONTROLLED AXES 3

CIRCUIT BREAKER/DISTRIBUTOR PANEL SC009 11131

CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.

CIRCUIT BREAKERS .... 18 EACH
POWER CAPABILITY .... 10 AMPS

INDICATORS-CAUTION AND WARNING SC010 11132

A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.

INDICATORS 40
.... MASTER ALARM MEMORY
.... POWER/TEST CONTROLS

RECORDER-TAPE SC011 11111

RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND DISPLAY CONSOLE.

BANDWIDTH .... DC TO 200 KHZ
CHANNELS 14
TIME MARKS .... EDGE TRACK
RECORDED FORMAT .... DIGITAL

ANNUNCIATORS-ADVISORY SC012 21132

DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.

ANNUNCIATOR-VISUAL .... 12 IN DUAL BANKS
DISPLAY TYPE .... RED, WHITE, GREEN
ANNUNCIATOR-AUDIO .... HORN

ATMOSPHERIC AND SPACE PHYSICS

BOOM POSITION TV DISPLAY AP001 11111

DISPLAY MEDIUM RESOLUTION TELEVISION OF EXPERIMENT BOOM POSITIONS BEFORE, DURING AND AFTER EACH EXPERIMENT REPETITION.

RESOLUTION .... 525 LINES
FRAME RATE .... 30 FRAMES/SEC
BANDWIDTH .... VHF RANGE

EXPERIMENT TV DISPLAY AP002 11111

DISPLAY HIGH RESOLUTION TELEVISION PICTURES OF AREAS OF INTEREST IN REAL TIME OR FROM VIDEO RECORDERS AT VARIOUS SPEEDS.

RESOLUTION...................... 525 LINES
FRAME RATE...................... 30 FPS
BANDWIDTH....................... UHF RANGE

SPECTRUM ANALYZER AP003 41111

MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE RATIO AND MULTIPLE RATIO OF VARIOUS FREQUENCY SOURCES.

BANDWIDTH .... 20 HZ TO 300 MHZ
SENSITIVITY .... 20 NANOVOLTS
ACCURACY .... +/- 0.4 DB

MULTI-CHANNEL ANALYZER AP004 11111

MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE RATIO AND MULTIPLE RATIO OF MULTIPLE FREQUENCY SOURCES SIMULTANEOUSLY.

BANDWIDTH .... 0 TO 10 MHZ
TIME BASE .... 200 MHZ CLOCK
MEMORY SIZE .... 1024, 4096, 8192 CHANNELS

WAVE ANALYZER AP005 11111

DETECTION OF SIGNAL AMPLITUDE AND FREQUENCY INFORMATION

BANDWIDTH .... 10 TO 600 KHZ
FREQUENCY RESOLUTION .... 10 HZ
SENSITIVITY .... 3 MV TO 30 V FS
CHANNELS .... 2 MINIMUM

WAVE ANALYZER AP006 11111

DETERMINE, SEPARATE AND ANALYZE VARIOUS FREQUENCY COMPONENTS OF INPUT SIGNALS (IE FUNDAMENTAL, HARMONICS, INTERMODULATION PRODUCTS, ETC.).

BANDWIDTH .... 1 KHZ TO 1.5 MHZ
FREQUENCY RESOLUTION .... +/- 1.0 %
SENSITIVITY .... 10 MV TO 100 V
CHANNELS .... 2 MINIMUM

PATCH PANEL, COAXIAL AP007 01111

MULTIPLE INPUT PANEL CAPABLE OF CHANNELING HIGH FREQUENCY RF ENERGY TO APPROPRIATE INSTRUMENTS WITH MINIMUM LOSS AND INTERFERENCE.

FREQUENCY COUNTER AP008 11111

DIRECT MEASUREMENT OF FREQUENCY AND/OR SIGNAL REPETITION RATE.

BANDWIDTH .... 0 TO 35 MHZ
SENSITIVITY .... 10 MV RMS
TIME BASE .... 100KHZ TO 10 MHZ

AUTOMATIC DISPLAY GENERATOR AP009 11111

PROVIDES 3D DISPLAY

CAMERA STILL AP010 11111

RECORD EXPERIMENT PHENOMENA

FILM SIZE....................... 35MM
SHUTTER SPEED................... 1 SEC TO 1/500 SEC

X-Y RECORDER AP011 21111

REAL-TIME ACCURATE REPRODUCTION OF SPECTRAL DATA SOURCES PLOTTED ON CARTESIAN COORDINATES.

CHANNELS 1
ACCURACY .... +/- 0.2 % FS

RECORDER - STRIP CHART AP012 21111

RECORD HARD COPY DATA FROM LOW FREQUENCY ANALOG INVESTIGATIONS

FREQUENCY RESPONSE .... DC TO 150 HZ
CHANNELS .... EVENT, TIME, 2- DATA
ACCURACY .... +/- 0.5 PCT

RECORDER - STRIP CHART AP013 21111

RECORD HARD COPY DATA.

CHANNELS........................ 6

TAPE RECORDER - ANALOG AP014 11111

RECORD AND PLAYBACK OF ANALOG DATA IN SUPPORT OF ATMOSPHERIC AND SPACE PLASMA PHYSICS SORTIE LABORATORY INVESTIGATIONS.

BANDWIDTH .... 2 MHZ
CHANNELS 14
RECORDING FORMAT .... FM

OSCILLOSCOPE AP015 21111

MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATING

BANDWIDTH .... 500 MHZ
CHANNELS 2
DEFLECTION FACTOR .... - MV
PHOTOGRAPHIC CAPABILITY .... YES

CAMERA,STILL AP016 21111

POLAROID CAMERA TO RECORD TRACES ON OSCILLOSCOPE

FILM FORMAT..................... POLAROID 107 BLACK/WHITE
3.25X4.25IN(82.55X107.95MM)
LENS............................ 56MM F3.5 TO F22
SHUTTER SPEEDS.................. B TO 1/60 SEC
FIELD OF VIEW................... 40 DEGREES

TAPE RECORDER - DIGITAL AP017 21111

RECORDING AND PLAYBACK OF DIGITAL DATA COMPATABLE WITH ANY ON-BOARD COMPUTING EQUIPMENT.

BANDWIDTH .... 2 MHZ
CHANNELS 6
SIGNAL .... 0 TO 5 VDC DIGITAL

COMPUTER AP018 21111

COMPUTER CAPABILITY TO SUPPORT ATMOSPHERIC AND SPACE PLASMA PHYSICS INVESTIGATIONS.

WORD SIZE .... 16 BIT
IP/OP MEMORY TRANSFER........... 1E+06--16 BIT WORDS/SEC
CORE MEMORY .... 32E+03 WORDS
IP/OP CHANNELS 45

KEYBOARD DISPLAY TERMINAL AP019 11111

GENERAL PURPOSE INPUT KEYBOARD ALLOWING FOR PROGRAMING, DATA INPUT AND UPDATE, AND DATA MANIPULATION FOR ONBOARD ANALYSIS

STATUS PANEL AP020 21111

DISPLAY TERMINAL WITHOUT KEYBOARD PROVIDING STATUS OF EXPERIMENT FUNCTIONS

SPECIAL DATA ACQUISITION PANEL AP021 11124

BATTERY CONTROL AND MONITOR AP027 11114

CAMERA - LINE AP029 11111

TIME CODE GENERATOR AND DISPLAY AP032 11111

ACCURATE FREQUENCY, TIME INTERVAL AND TIME KEEPING CAPABILITIES.

OUTPUTS......................... 100 KHZ, 1 MHZ, 5 MHZ
ACCURACY .... 5E-10 PARTS PER DAY

REMOTE SENSING PLATFORM GIMBAL CONTROL AP033 11134

XUV NORMAL INCIDENCE SPECTROMETER CONTROL AP034 11114

UV-VIS-NIR SCANNING SPECTROMETER CONTROL AP035 11114

HIGH RESOLUTION FOURIER SWIR SPECTROMETER CONTROL AP036 11114

CRYOGENIC IR FOURIER SPECTROMETER CONTROL AP037 11114

IR RADIOMETER CONTROL AP038 11114

FABRE-PEROT INTERFEROMETER CONTROL AP039 11114

UV,VIS DOCUMENTATION CAMERA CONTROL AP040 11114

ELECTROSTATIC ANALYZER CONTROL AP041 11134

MAGNETIC ANALYZER CONTROL AP042 11134

KEV-MEV PARTICLE DETECTOR CONTROL AP043 11134

TOTAL ENERGY DETECTOR CONTROL AP044 11134

LIDAR AND GIMBAL PLATFORM MONITOR AP045 11134

TRANSMITTER - 0.2 TO 2.0 MHZ AP901 11111

VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.

FREQUENCY BANDWIDTH .... 0.2 TO 2.0 MHZ
TRANSMITTER POWER .... 10 KW

TRANSMITTER - 2.0 TO 20.0 MHZ AP902 11111

VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.

FREQUENCY BANDWIDTH .... 2.0 TO 20.0 MHZ
TRANSMITTER POWER .... 10 KW

TRANSMITTER - 0.3 TO 200 KHZ AP903 11111

VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.

FREQUENCY BANDWIDTH .... 0.3 TO 200.0 KHZ
TRANSMITTER POWER .... 1.0 KW

ELECTROSTATIC WAVE TRANSMITTER AP904 11134

COUPLER - ANTENNA (0.2 TO 2.0 MHZ) AP909 11111

ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.

FREQUENCY BANDWIDTH .... 0.2 TO 2.0 MHZ

COUPLER - ANTENNA (2.0 TO 20.0 MHZ)	AP910	11111

ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.

FREQUENCY BANDWIDTH .... 2.0 TO 20.0 MHZ

COUPLER - ANTENNA (0.3 TO 200 KHZ)	AP911	11111

ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.

FREQUENCY BANDWIDTH .... 0.3 TO 200 KHZ

BANDPASS FILTER - WAVE ANALYSIS	AP912	21111

DETERMINATION OF FREQUENCY AND AMPLITUDE INFORMATION ABOUT THE CARRIER AND SIDEBANDS.

FREQUENCY RANGE .... 300 HZ TO 20.0MHZ
ATTENUATION .... 75 DB
ACCURACY .... +/- 2 %

PULSE WAVE ANALYZER- C.W. MODES	AP913	11111
PATCH PANEL	AP914	51111

INTERFACE CONNECTIONS OF VARIOUS RF RECEIVERS WITH SELECTED TEST EQUIPMENT FOR WAVE ANALYSIS.

AMPLIFIERS - WAVE ANALYSIS	AP915	21111
FREQUENCY SYNTHESIZER - WAVE ANALYSIS	AP916	21111

TRANSLATION OF A STABLE FREQUENCY OF A PRECISE STANDARD TO ANY OF A SELECTED INVESTIGATION REQUIREMENT.

FREQUENCY BANDWIDTH .... DC TO 13 MHZ IN 5 RANGES
FREQUENCY RESOLUTION .... 0.01 TO 10 KHZ
FREQUENCY STABILITY .... 1E-07 PARTS PER DAY

MAIN BOOM A CONTROL	AP917	11134
PLATFORM BOOM A CONTROL	AP918	11134
MAIN BOOM B CONTROL	AP919	11134
ALIGNMENT TV CONTROL	AP920	11134
GIMBALLED PLATFORM CONTROLS	AP921	11134
5M BOOM CONTROL	AP922	11134
BOOM A POWER SUPPLY & DATA SYS CONTROL	AP923	11134
BOOM B TARGET CONTROL	AP924	11134
ACCEL-DECEL CONTROL	AP925	11134
DISCHARGE FILAMENT HEATER CONTROL	AP926	11134
DISCHARGE POTENTIAL CONTROL	AP927	11134
PULSE SEQUENCE & BURST LENGTH CONTROL	AP928	11134
GAS SELECTION & PRESSURE CONTROL	AP929	11134
NEUTRALIZER EMISSION & BIAS CONTROL	AP930	11134
CHARGE EXCHANGE CHANNEL ACTUATOR CONTROL	AP931	11134
BEAM CURRENT MONITOR	AP932	11134
ELECTRON BEAM VOLTAGE; CURRENT HEATER CONTROL	AP933	11134
ELECTRON BEAM BURST LENGTH & MAGNITUDE CONTROL	AP934	11134
ELECTRON BEAM EXPANSION LENS CONTROL	AP935	11134
ELECTRON BEAM CURRENT MONITOR	AP936	11134
PHASE, ANGLE, CURRENT MONITOR	AP937	11134
MPD ARC VOLTAGE LEVEL CONTROL	AP938	11134
MPD ARC BURST CURRENT DURATION CONTROL	AP939	11134
MPD ARC PULSE SEQUENCE	AP940	11134
MPD ARC BEAM CURRENT MONITOR	AP941	11134
GAS SELECTION & PRESSURE CONTROL	AP942	11134
SPHERICAL ION PROBE CONTROL	AP943	11134
CYLINDRICAL ION PROBE CONTROL	AP944	11134
PLANAR ELECTRON PROBE CONTROL	AP945	11134
SEGMENTED PLANAR PROBE CONTROL	AP950	11134
DEP. SAT. INSTRUMENT CONTROL & HOUSEKEEPING	AP959	11134
DEP. SAT EJECTION MECHANISM CONTROL	AP960	11134
PHOTOMETER HIGH VOLTAGE SUPPLY CONTROL	AP961	11134
PHOTOMETER AMPLIFIERS CONTROL	AP962	11134
TV SYS CONTROL - IMAGE INTENSIFIER CONTROL	AP963	11134
CANNISTER EJECTION CONTROL	AP964	11134
PROJECTILE CAMERA CONTROL	AP965	11134
CANNISTER MONITOR	AP966	11134
SHAPED CHARGE EJECTION CONTROL	AP967	11134
SHAPED CHARGE MONITOR	AP968	11134
BALLOON EJECTION CONTROL	AP969	11134
GAS CONTROL SYSTEM	AP970	11134

ORIGINAL PAGE IS
OF POOR QUALITY

EARTH OBSERVATIONS

HEAT EXCHANGER EC001 11121

EXCHANGER TO TRANSFER HEAT FROM THE CLOUD PHYSICS LAB TO THE SPACELAB HEAT REJECTION SUBSYSTEM

HEAT TRANSFER RATE..............165 BTU/HR (54 WATTS THERMAL)
SPACELAB COOLANT INLET TEMP...43F (6C)
CPL COOLANT OUTLET TEMP........45F (7C)

HEAT EXCHANGER EC001 11121

PROVIDE HOT FLUID TO CPL

CPL COOLANT OUTLET TEMP........100F (38C)
HEAT RATE (EST)................170BTU/HR (50 WATTS THERMAL)

RESERVOIR EC001 11113

STORES COOLANT.

PUMP EC001 11111

PUMP COOLANT IN CPL COOLANT SUBSYSTEM

FLOW RATE(EST)..................40LBS/HR (300CC/MIN)
HEAD(EST).......................1 PSI (6.9E03 N/M2)

TEMPERATURE CONTROLLER EC001 11111

CONTROLS COOLANT TEMPERATURE TO CONTROL CHAMBER WALL TEMPS

TEMPERATURE RANGE..............-76 TO 104F (-60 TO 40C)
ACCURACY.......................+/-0.2F (0.1C)

CRYOGENIC COOLER ASSEMBLY EC001 11114

PROVIDE LOW TEMPERATURE HEAT SINK TO EXPERIMENT CHAMBERS

MAXIMUM TEMPERATURE............-76F (-60C)
HEAT SINK CAPACITY(EST)........1000BTU (290W THERMAL)

TEMPERATURE SENSORS EC001 41111

MEASURE COOLANT TEMPERATURES

OPERATING TEMPERATURE RANGE...-76 TO 104F (-60 TO 40C)
ACCURACY.......................+/-0.02F(+/-0.01C)

CRT DISPLAY EC001 11111

PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMBERICS,DYNAMIC AND DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.

DIGITAL VISUAL DISPLAY EC001 11111

DISPLAY NUMERIC DATA

ALPHANUMERIC KEYBOARD EC001 11111

ALLOWS CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR EXPERIMENT CONTROL AND DATA ANALYSIS

KEYBOARD.......................TYPEWRITER TYPE
INTERFACE DESCRIPTION..........DIGITAL-32-BIT WORD

SOLENOID VALVES EC001 101121

CONTROL FLUID FLOW

MODULATING VALVE EC001 21121

ADJUST FLUID FLOW

PRESSURE REGULATORS EC002 51121

PRESSURE REGULATING VALVE FOR GASEOUS PRESSURIZATION SUBSYSTEM

REGULATION RANGE...............2.7 TO 14.7 PSIA(140 TO 760TORR)
UPSTREAM PRESSURE(EST).........20 PSI (1.4E05 N/M2)

PRESSURE REGULATOR EC002 11121

VALVE REGULATING SUPPLY PRESSURE

REGULATION PRESSURE(EST)......20 PSI (1.4E04 N/M2)
MAX UPSTREAM PRESSURE.........300 PSI (2.1 E06 N/M2)

SOLENOID VALVES EC002 111121

GAS SHUTOFF VALVES

CONDITIONING CHAMBER EC015 11134

THE CONDITIONING CHAMBER IS MADE UP OF A PRESSURE SHELL, A POSITIVE EXPULSION REGULATOR AND A WV AEROSOL CONDITIONER. THIS CHAMBER CONDITIONS THE GAS SAMPLE PRIOR TO ITS INJECTION INTO THE CLOUD CHAMBER

OPERATING PRESSURE(EST)........20PSIA (14E03N/M2)
OPERATING TEMPERATURE..........32 TO 86F (0 TO 30C)
VOLUME.........................2 CU.FT. (0.0565 CU. METERS)

PRESSURE SENSORS EC002 51111

MEASURE PRESSURES THROUGH OUT THE SYSTEM

RANGES.........................2 TO 20 PSIA (100 TO 1000 TORR)
.......................10 TO 50 PSI (6.9E4-34.5E4N/M2)
.......................10 TO 300 PSI (34.5E4-2.1E6N/M2)
ACCURACY.......................1% OF FULL SCALE

HUMIDIFIER ASSEMBLY EC003 11135

THIS ASSEMBLY CONSISTS OF AN EVAPORATOR, A HEATER, A WATER TRAP, A METERING PUMP AND A WATER TANK WITH AN INTEGRAL BLADDER. THIS ASSEMBLY GENERATES THE WATER VAPOR NECESSARY FOR CLOUD CREATION.

DRY AIR FLOW RATE...............175CFM (5 LITERS/MIN)
MAXIMUM TEMPERATURE............77F (45C)
HUMIDITY RANGE.................0 TO 100%
HEATER CAPACITY(MIN)...........17BTU/HR (5W THERMAL)
HEATER FEED RATE (MAX) .... 0.02 LB/HR (9.1 CC/HR)
WATER TANK CAPACITY............3LBS (1.35KG)

DEW POINT SENSOR EC003 11113

THIS SENSOR MEASURES THE DEW POINT OF THE GAS SAMPLE

MEASUREMENT RANGE..............10 TO 98%
ACCURACY.......................+/-1%

LIQUID WATER CONTENT METER EC003 11235

MONITORS LIQUID WATER CONTENT WITHIN THE EXPANSION CHAMBER FOR THE PURPOSE OF ACCURATE WATER BUDGET ACCOUNTS. CURRENT CONCEPTS USE OPTICAL TECHNIQUES TO MEASURE THE WATER DROPLETS IN AIR.

ACCURACY.......................+/-0.05%

CONDENSER - WATER EC003 11131

COLLECTS WATER VAPOR BY CONDENSING WATER CONTENT OF GAS SAMPLE

CONDENSATION RATE(MAX).........0.2LB/HR (910CC/HR)
TEMPERATURE(MIN)...............45F(7C)

STORAGE TANK - EARTH SAMPLE EC004 11113

THIS TANK STORES SAMPLES OF EARTH GASSES. THE ASSEMBLY CONSISTS OF A PRESSURE VESSEL, A POSITIVE EXPULSION REGULATOR AND A BLADDER.

PRESSURE.......................1 ATM (760 MM HG)
VOLUME.........................10 CU.FT.(0.28 CU.METERS)

GAS SAMPLE STORAGE TANKS EC004 51111

PRESSURE VESSELS FOR STORING EXPERIMENT GAS SAMPLES.

MAX PRESSURE(EST)..............300 PSI (2.1E06 (N/M2)
VOLUME   1 CU.FT. (0.028 CU. METERS)

SUMP STORAGE TANK EC004 11111

STORE GAS SAMPLES AFTER EXPERIMENT EVALUATION.

MAX PRESSURE (EST).............150PSI(1.05E06N/M2)
VOLUME.........................10 CU.FT. (0.28 CU.METERS)

FLOW CONTROL ASSEMBLY EC004 11124

THIS ASSEMBLY CONTROLS THE FLOW OF GASSES IN THE CPL. IT IS MADE UP OF PLUMBING COMPONENTS, SOLENOID VALVES, A FILL ASSEMBLY, A VENT ASSEMBLY, SAFETY COMPONENTS AND A MIXING SUBASSEMBLY.

SUMP COMPRESSOR EC004 11111

COMPRESS EXPENDED EXPERIMENT GAS SAMPLES INTO SUMP STORAGE TANK

COMPRESSION RATIO(MAX).........10 TO 1

DC-DC CONVERTER(VOLTAGE CONTROLLED DC) EC005 11111

CONVERTS SPACELAB POWER TO VOLTAGE USABLE BY ELECTRICAL FIELD GENERATING COMPONENTS

INPUT VOLTAGE..................28V DC
OUTPUT VOLTAGE.................TBD

DC-DC CONVERTER (LOW FREQUENCY AC) EC005 11111

CONVERT POWER INTO USABLE FORM FOR ELECTRIC FIELD GENERATING CAPACITOR

FREQUENCY......................0 TO 100HZ
WAVE SHAPE.....................SQUARE
AMPLITUDE......................0 TO 3000 V/M

ELECTRIC FIELD CONTROLLER EC005 11114

PROVIDE CONTROL FUNCTION FOR ELECTRIC FIELD GENERATOR. CONTROLLER SUPPORT BOTH AC AND DC POWER SUPPLIES

ACCUSTICAL GENERATOR EC013 11111

VARIABLE FREQUENCY AUDIO DRIVERS USED TO POSITION AND CONTROL WATER DROPLETS OR ICE PARTICLES IN EACH OF THREE MUTUALLY PERPENDICULAR AXES. EACH DRIVER CAN BE CONTROLLED INDEPENDENTLY IN FREQUENCY AND AMPLITUDE

FREQUENCY RANGE................0 TO 10KHZ
AMPLITUDE......................0 TO TBD DB

TRANSDUCER - ACOUSTICAL EC013 241111

MEASURE SOUND INTENSITY LEVEL

INTENSITY LEVEL............... 0 TO TBD DB

AMPLIFIER - ACOUSTIC GENERATOR EC013 11111

AMPLIFY SIGNAL TO ACOUSTIC GENERATOR

POWER..........................45W

LASER EC013 11111

POLARIZED, COLLIMATED LIGHT SOURCE USED FOR PARTICLE HEATING AND MOTION CONTROL AS WELL AS TO ASSESS OPTICAL SCATTERING PROPERTIES OF ICE CRYSTALS

LASER - POSITIONING SERVO CONTROL   EC013   41114

PROVIDES FEEDBACK AND CONTROL SIGNAL TO LASER DRIVER FOR PROPER POSITIONING AND HEATING OF PARTICULATE SPECIMENS

LIQUID DROP GENERATOR   E0006   41235

GENERATES SINGLE DROPLETS BY MANUAL OR SYSTEM CONTROL. DROPLETS ARE PROPELLED INTO THE EXPERIMENT CHAMBERS FOR EXAMINATION

    FORMATION FREQUENCY(MAX).......10/SEC
    DROPLET DIAMETER...............10 MICROMETERS TO 1 CM
    DROPLET UNIFORMITY.............WITHIN 5 %

ELECTRONIC DRIVER ASSEMBLY   EC006   41114

THE ELECTRONIC DRIVER ASSEMBLY CONTROLS THE LIQUID DROP GENERATOR. IT CONSISTS OF A GENERATOR POWER SUPPLY, A PARTICLE CHARGER POWER SUPPLY AND A DUAL PULSE GENERATOR.

ICE PARTICLE GENERATOR   EC007   31235

GENERATE ICE PARTICLES FOR TEST IN ICE DIFFUSION, EXPANSION AND GENERAL CHAMBERS

    ICE CRYSTAL SIZE...............50 MICROMETERS TO 1 CM

DROPLET CLOUD AEROSOL GENERATORS   EG008   11135

GENERATE AEROSOLS FOR EXPERIMENTATION

    PARTICLE CONCENTRATION.........10 UP TO 10000/CC
    CLOUD FORM.....................POLYDISPERSED AND MONODISPERSED
    PARTICLE SIZE..................10E-4 TO .1 CM
    PRODUCTION RATE................UP TO 10E5 HZ

LARGE AND GIANT NUCLEI AEROSOL GENERATOR   E0008   11135

SAME AS DROPLET CLOUD AEROSOL GENERATOR

AITKEN AEROSOL GENERATOR   E0008   11135

SAME AS DROPLET CLOUD AEROSOL GENERATOR

DIGITAL COMPUTER   EC010   11111

PROVIDES DATA PROCESSING AND CONTROL FUNCTIONS FOR THE CPL

TAPE RECORDER   EC010   11111

RECORD DATA ON MAGNETIC TAPE

    BIT RATE.......................100B/S
    STORAGE CAPACITY...............3.5EC7BITS

SIGNAL CONDITIONING ELECTRONICS   E0010   11111

ELECTRONICS SUPPORTING DATA MANAGEMENT SUBSYSTEM

OPTICAL PARTICLE COUNTER   E0011   11235

THIS DEVICE WILL BE A SIZE ANALYZER. THE ANALYZER CONSISTS OF A PHOTOMULTIPLIER, AN AMPLIFICATION STAGE AND SUPPORTING ELECTRONICS

    SENSITIVE PARAMETER............LIGHT SCATTERED FROM PARTICLES
    PARTICLE SIZE..................>0.3 MICROMETERS

NUCLEI MASS MONITOR SYSTEM   E0011   11235

THIS DEVICE MEASURES THE TOTAL PARTICULATE MASS PER UNIT VOLUME. THE SYSTEM USES A CRYSTAL OSCILLATOR WHICH ANGES ITS RESONANT FREQUENCY AS PARTICLES ARE DEPOSITED ON IT.

    PARTICLE COLLECTION............ELECTROSTATIC PRECIPITATION
    PARTICLE SIZE..................0.01 TO 20 MICROMETERS

ELECTRICAL PARTICLE COUNTER   EC011   11135

THIS ANALYZER MEASURES THE SIZE DISTRIBUTION OF PARTICLES. THE PARTICLES ARE IONIZED AND THERE MOBILITY AS A FUNCTION OF ELECTRIC FIELD IS MEASURED TO GIVE AN INTEGRAL SIZE DISTRIBUTION

    PARTICLE SIZE..................0.01 TO 1.0 MICROMETER
    FLOW RATE......................1.8CFM (50LITERS/MIN)
    INTEGRAL DISTRIBUTION CAPABILITY.....YES

ANALYZER - MULTICHANNEL   EC011   11111

ALLOW SELECTIVE ANALYSIS OF COUNTER DATA

EXPANSION CLOUD CHAMBER   EC014   11135

CHAMBER PROVIDING SIMULATION OF LONG TERM, NATURAL CLOUD DURING AN ADIABATIC EXPANSION

    DIMENSIONS.....................11.8IN.(30CM)DIA. X 17.7IN (45CM)LONG
    VOLUME.........................1.12CU.FT.(31.8L)
    OPERATING TEMPERATURE.......... -76F TO 104F (-60 TO 40C)
    UPPER AND LOWER ENDS TEMP
        DIFFERENTIAL...............0 TO 18F(0 TO 10C)
    END TEMPERATURE TOLERANCE......+/-0.1F (+/-0.5C)
    OPERATING PRESSURE.............2.7 TO 14.7 PSIA(140 TO 760TORR)
    PRESSURE RATE OF CHANGE........19.4PSI/SEC (1000TORR/SEC)
    PRESSURE RATE TOLERANCE........+/-1%
    MAXIMUM VOLUME EXPANSION...... V/V OF 0.5+/-0.1%
    CIRCULAR ENDS CONTAIN ELECTRICALLY CONDUCTIVE PLATES TO SERVE
        AS EQUIPOTENTIAL SURFACES FOR THE ELECTRIC FIELD MOTION
        CONTROL SYSTEM

CONTINUOUS FLOW DIFFUSION CLOUD CHAMBER   E0014   11135

SUPERSATURATION IS CONTROLLED BY THE TEMPERATURE OF WATER COVERING THE UPPER AND LOWER SURFACES OF THE CHAMBER. IT WILL BE USED FOR CLOUD CONDENSATION NUCLEATION EXPERIMENTS

    DIMENSIONS.....................11.8IN(30CM) X 11.8IN(30CM) X 2IN(5CM)
    VOLUME.........................0.16CU.FT.(4.5L)
    INNER PLATE DIMENSIONS....... 11.8IN(30CM) X 10IN(25CM) SPACED 0.5IN(1.3CM)APART
    ISOTHERMAL TEMP CONTROL.......+/-0.1F(0.05C)
    UPPER AND LOWER SURFACE
        TEMPERATURE DIFFERENCE..... 0 TO 18F (0 TO 10C)
    SURFACE TEMP CONTROL...........+/-0.1F(0.05C)
    OPERATING PRESSURE.............14.3 TO 14.7PSIA(740 TO 760TORR)
    PRESSURE MEAS. ACCURACY........+/-0.2%
    MAX PRESSURE CHANGE RATE.......0.08PSI/SEC(0.4TORR/SEC)

STATIC DIFFUSION ICE CLOUD CHAMBER   EC014   11135

THIS IS A NAKAYA TYPE CHAMBER WHICH UTILIZES ICE SURFACES TO PROVIDE CONTROLLED SUPERSATURATION RELATIVE TO ICE.

    DIMENSIONS.....................15.75IN(40CM)DIA X 7.9IN(20CM) LONG
    VOLUME.........................0.444CU.FT.(4.5L)
    OPERATING TEMPERATURE..........-40 TO 77F(-40 TO 25C)
    TEMP MEAS. ACCURACY............+/-1.8F(+/-1.0C)
    UPPER AND LOWER SURFACE
        TEMPERATURE DIFFERENCE......UP TO 36F (20C)
    SURFACE TEMP.MEAS.ACCURACY....+/-0.1F(+/-0.05C)
    OPERATING PRESSURE.............1.9 TO 14.7PSIA(100 TO 760TORR)
    PRESSURE MEAS. ACCURACY........+/-0.19PSI(+/-10TORR)

STATIC DIFFUSION LIQUID CLOUD CHAMBER   EC014   11135

A TWOMEY TYPE CHAMBER USED FOR EXPERIMENTS REQUIRING ABOVE FREEZING TEMPERATURES AND SUPERSATURATION OF THE LIQUID RELATIVE TO WATER. SUPERSATURATION IS CONTROLLED BY THE TEMPERATURES OF THE WATER COVERING CHAMBER UPPER AND LOWER SURFACES.

    DIMENSIONS.....................6IN.(15 CM)DIA.X0.6IN(1.5CM)LONG
    VOLUME.........................0.01CU.FT.(0.27L)
    OPERATING TEMPERATURE......... 32F TO 68F (0 TO 30C)
    END SURFACE MAXIMUM
        TEMPERATURE DIFFERENTIAL....18F(10F)
    SURFACE TEMP.MEAS.ACCURACY....0.1V(0.05C)
    OPERATING PRESSURE.............2.84 TO 14.7PSIA(140 TO 760TORR)

GENERAL CLOUD CHAMBER   EC014   1117

THIS CHAMBER WILL BE USED FOR MANY EXPERIMENTS THAT REQUIRE A RELATIVE HUMIDITY BELOW 100% AND MINIMUM TEMPERATURE CONTROL. PROVISIONS WILL BE MADE FOR GENERATING VARIOUS ELECTRIC FIELDS, POSITIONING DEVICES(SOUND, OPTICAL, ELECTRICAL), AND REMOTE DROPLET SIZING.

    DIMENSIONS.....................11.8IN(30CM) ALL SIDES (CUBE)
    VOLUME.........................0.95CU.FT.(27L)
    OPERATING TEMPERATURE..........5C TO 86F(10 TO 30C)
    OPERATING PRESSURE.............2.84 TO 14.7PSIA(140 TO 760TORR)
    ELECTRIC FIELD PLATES LOCATED ON OPPOSITE SIDES
    ACOUSTIC DRIVERS LOCATED ON THREE MUTUALLY PERPENDICULAR SIDES

AC POWER CONTROLLER   E0017   11111

REGULATES AND CONTROLS AC POWER

    REGULATION RANGE...............TBD

DC POWER CONTROLLER   E0017   11111

REGULATES AND CONTROLS DC POWER

    REGULATION RANGE...............TBD

MOTION PICTURE CAMERA (FAST FRAME)   E0009   11111

FAST FRAME RATE CAMERA TO RECORD DROPLET COLLISIONS

    FRAME RATE.....................100/SEC
    RECORDING DURATION.............20SEC
    FIELD OF VIEW.................. WIDE ANGLE

STILL CAMERA   E0009   11111

RECORD CLOUD CHAMBER PHENOMENA

    FRAME RATE.....................2/SEC
    SHUTTER SPEED..................1SEC TO 1/500SEC
    CAPACITY.......................500FRAMES
    INTERCHANGABLE LENSES
    FILM SIZE......................35MM

STILL CAMERA   E0009   11111

RECORD CLOUD CHAMBER PHENOMENA

    SHUTTER SPEED..................1SEC TO 1/500SEC
    RESOLUTION.....................2 MICROMETERS
    DEPTH OF FIELD.................1MM
    FRAME SIZE.....................70MM

MICROSCOPE   E0017   11111

MAGNIFIED OBSERVATIONS

    MAGNIFICATION FACTOR...........10 TO 100X
    OBSERVATION MODE...............VISUAL OR PHOTOGRAPHIC

STEREO MICROSCOPE   E0017   11111

MAGNIFIED OBSERVATIONS

MAGNIFICATION FACTOR...........10 TO 100X
OBSERVATION MODE...............VISUAL OR PHOTOGRAPHIC
WORKING DISTANCE...............UP TO 4IN(10CM)

MICROSCOPE (HIGH MAGNIFICATION) EC017 11111

MAGNIFIED OBSERVATIONS

MAGNIFICATION FACTOR...........100 X 1000X
OBSERVATION MODE...............TRINOCULAR(CAMERA ATTACHMENT)

OSCILLOSCOPE EC017 11111

SUPPORT MAINTENANCE ACTIVITIES AND SPECIAL DATA ACQUISITION

FREQUENCY RANGE .... DC TO 10.0 MHZ
OBSERVATION MODE .... VISUAL AND CAMERA (1 HR STORE)

TV MONITOR EC012 11111

DISPLAY TV CAMERA OUTPUT SHOWING CHAMBER PHENOMENA

VIDICON EC012 11131

RECORD CHAMBER PHENOMENA

RESOLUTION.....................HIGH
LIGHT LEVEL....................LOW
IMAGE MAGNIFICATION............YES
IMAGE INTENSIFICATION..........YES

IMAGE DEVICE LIGHTING EC009 11114

PROVIDES LIGHTING FOR VARIOUS OPTICAL RECORDING ACTIVITIES. CONSISTS OF CONTINUOUS LIGHTING, STROBOCOPE AND LASER BEAM LIGHT SOURCES

HIGH INTENSITY LIGHT DURATION..<1SEC

OPTICAL DETECTOR EC005 11235

SOLID STATE DETECTOR TO OBTAIN DATA CONCERNING SCATTERING PROPERTIES OF ICE CRYSTALS AND POSSIBLY EXTREME DROPLET SIZE CHANGE DATA.

DROPLET SIZE DISTRIBUTION METER EC005 11235

THIS UNIT WILL DETERMINE DROPLET SIZE DISTRIBUTIONS WITHIN A CHAMBER UTILIZING OPTICAL TECHNIQUES

IR MICROSCOPE EC017 11111

DETERMINE SURFACE TEMPERATURE OF DROPLETS AND ICE CRYSTALS

SENSITIVITY.....................+/-0.54F(+/-0.3C) AT 5F (-15C)

OPTICAL SENSORS EC013 121111

SENSOR FOR CONTROL OF PARTICLE CHARACTERISTICS AND OPTICAL ENERGY SOURCES

DIGITAL TAPE RECORDER EC086 11111

PROVIDES FOR RECORDING SENSOR DIGITAL OUTPUT DATA.

TAPE SIZE .... 1 INCH
TRACKS 9
TAPE SPEED .... VARIABLE
DATA RATE .... 1.3E+06 BPS
REEL SIZE .... 12 INCHES DIA

LIDAR TRANSMITTER EC088 11112

PROVIDES SIGNAL SOURCE TO MEASURE CLOUD HEIGHTS AND AEROSOL DISTRIBUTION.

WAVE LENGTH .... 6328 ANGSTROMS
ILLUMINATION MODES .... RUBY, DOUBLED RUBY, DYE,
DOUBLED DYE

RECEIVER, TELESCOPE EC089 11112

RECEIVES TRANSMITTER RETURNED SIGNALS.

INSTANTANEOUS FOV .... 0.0018 RAD
POINTING ACCURACY .... 0.0087 RAD
POINTING STABILITY .... 0.0087 RAD
POINTING STABILITY RATE ...... 0.0017 RAD PER SEC
POINTING DURATION .... 7200 SEC

DIGITAL RECORDER EC091 11111

PROVIDES FOR RECORDING DIGITAL OUTPUT DATA.

TAPE SIZE .... 1 INCH
TRACKS 9
REEL SIZE .... 12 INCHES
TAPE SPEED .... VARIABLE
DATA RATE..................... 60 MBPS

OSCILLOSCOPE EC096 11111

MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATION.

BANDWIDTH 100MHZ
CHANNELS 2
SENSITIVITY .... 10 MV/DIVISION
TIME BASE .... VARIABLE
STORAGE CAPABILITY .... NO

TELESCOPE - TRACKING MEC 11135

USED FOR HIGH RESOLUTION VIEWING OF SPECIFIC TARGETS

INSTANTANEOUS FIELD OF VIEW...0.5DEG(124X)
...4.0DEG(16X)
FIELD OF VIEW(CROSS-TRACK)....0.5DEG AND 4.0DEG
POINTING ANGLE FROM NADIR
(PITCH, ALONG TRACK)........+70 TO -40DEG
POINTING ANGLE FROM NADIR
(ROLL, CROSS TRACK)..........+/-75DEG
TOTAL ANGULAR COVERAGE (CROSS-
TRACK) FROM NADIR (1FOV/2+
POINTING ANGLE)..............+/-75DEG
POINTING ACCURACY (1-SIGMA)...0.1DEG

VIEWER - WIDE ANGLE MEC 11235

USED FOR LARGE AREA VIEWING AND ORIENTATION. INSTRUMENT SIMILAR TO THE WILD NF2 NAVIGATION SIGHT USED WITH THE WILD-HEERBRUGG RC-10 METRIC CAMERA

INSTANTANEOUS FIELD OF VIEW...110DEG X 110DEG
...55DEG X 55DEG
...28DEG X 28DEG
FIELD OF VIEW..................360DEG IN AZIMUTH
POINTING ANGLE FROM NADIR
(PITCH, ALONG-TRACK).......0 TO 600DEG
TOTAL ANGULAR COVERAGE (CROSS-
TRACK) FROM NADIR (1FOV/2+
POINTING ANGLE)............+/-60DEG
POINTING ACCURACY (1-SIGMA)...2DEG

LONG WAVE INFRARED SPECTROMETER MEC 11111

USED FOR IDENTIFICATION OF TYPES OF ROCKS, SOILS AND SEDIMENTS

SPECTRAL RANGE.................0.4 TO 2.4 MICRONS
...............6.2 TO 15.5 MICRONS
RADIOMETRIC CHANNEL RANGE.....10 TO 12 MICRONS
INSTANTANEOUS FIELD OF VIEW...1 MILLI RADIAN DIA.
POINTING ANGLE FROM NADIR
(PITCH, ALONG TRACK).......+45DEG TO -10DEG
POINTING ANGLE FROM NADIR
(ROLL, CROSS TRACK).........+/-20DEG
POINTING ACCURACY.............0.3DEG

MAGNETIC TAPE RECORDER MEC 21111

ONBOARD DATA RECORDING OF SCIENTIFIC INSTRUMENT DATA

READ IN RATE...................100MBPS
STORAGE CAPACITY/MISSION......3E12 BITS

DATA BUFFERS, FORMATTERS MEC 21111

BUFFERS DATA FROM HIGH RESOLUTION WIDEBAND MULTISPECTRAL SCANNER

INPUT DATA RATE................200MBPS
OUTPUT DATA RATE...............100MBPS
INPUT DATA DUTY CYCLE..........33%

MULTIPLEXER MEC 11111

MULTIPLEX DATA FOR TRANSMISSION VIA SHUTTLE COMMUNICATION LINK

CRT DISPLAY MEC 61111

TWO CRT'S ARE LOCATED IN THREE CONSOLES FOR DATA DISPLAY OF ALPHANUMERICS AND GRAPHICS.

RESOLUTION.....................1000 LINES
CONTROL INPUT FORM.............DIGITAL
SCAN...........................RASTER
...........................CONICAL
PHOSPHOR CHARACTERISTICS.......FOUR-COLOR PENETRATION
SCREEN SIZE....................16IN (40CM)
CONTRAST.......................8 GRAY LEVELS

MICROFICHE READER MEC 11111

READER CONCURRENTLY DISPLAYS SEQUENCES OF MICROFILM RECORDS OF MAPS, REFERENCE SIGNATURES AND OTHER MATERIALS NEEDED FOR REAL TIME EVALUATION OF SENSOR FORMATS SELECTED FOR CRT DISPLAY

STORAGE CAPACITY...............73,000PAGES
RETRIEVAL SPEED................4 SECONDS MAX
INTERFACE......................STANDARD COMPUTER

MULTIFUNCTION KEYBOARD MEC 31111

CONSOLE CONTROL KEYBOARD WITH FUNCTION KEYS LABELLED BY COMPUTER. A SUPPORTING SOFTWARE LOGIC TREE FOR DATA ENTRY AND DISPLAY CALL UP CAN BE ENTER AT ANY LEVEL.

OPERATIONS CONTROL COMPUTER MEC 11111

THE COMPUTER SHALL PROVIDE THE FOLLOWING FUNCTIONS: COMMAND INTERPRETATION AND EXECUTION, ATTITUDE AND POINTING PROGRAM CONTROL AND COMPUTATION AND DATA MANAGEMENT SEQUENCING OPERATIONS

MEMORY SIZE....................14550 WORDS
ADD/MULT EXECUTE TIME..........5/30 MICRO SECONDS

EARTH AND OCEAN PHYSICS

FILM RECORDER	OP002	61121

PROVIDE PHOTOGRAPHIC RECORDINGS TO PROVIDE ALL WEATHER STEREO IMAGERY FOR TOPOGRAPHIC MAPPING, 3-D STRAIN FIELDS, EROSION, VOLCANIC MOTION AND POST-GLACIAL UPLIFT.

FILM TYPE .... 70 MM
FILM RATE .... 6 MM/SEC
INSTANTANEOUS FOV .... 0.088 RAD

MULTIFREQUENCY PROPAGATION RECEIVER/PROCESSOR & ANTENNA SYSTEM CONTROL UNIT	OP004	11134
MULTISPECTRAL SCANNER ELECTRONICS PACKAGE	OP006	11134
IR TEMPERATURE PROFILE RADIOMETER CONTROL UNIT	OP018	11134
CAMERA CONTROL	OP020	11134
GIMBAL CONTROL	OP020	11134
OPTICAL MONITOR CONTROL	OP021	11134
CONTAMINATION MONITOR GUAGE CONTROL	OP021	11134
MASS SPECTROMETER CONTROL	OP021	11134

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

SPACE PROCESSING APPLICATIONS

FLUID SUPPLY SYSTEM SPOO1 11134

THIS UNIT CONSISTS OF THREE ELEMENTS SUPPORTING ALL MATERIAL SCIENCE AND MANUFACTURING EXPERIMENTS. IT IS PART OF THE CORE SUBELEMENT PRESENT ON ALL MS/MS PAYLOADS. THE THREE ELEMENTS ARE AN INERT GAS UNIT, AN OXIDIZING GAS UNIT, AND A REDUCING GAS UNIT.

DIGITAL CLOCK SPOO1 11111

DIGITAL TIME DISPLAY. PART OF DIGITAL PROCESS PROGRAMMER ASSY

DISPLAY .... 4 DIGITS
DISPLAY TYPE .... LED

SCANNER PROGRAMMER SPOO1 11111

TRACKS COMPLEX FUNCTION AND TRANSLATES IT INTO A SIGNAL WHICH DRIVES EXPERIMENT CONTROLLER

ACCURACY.........................+-0.5% OF SPAN
REPEATABILITY..................+-0.1 OF SPAN

SIGNAL CONDITIONER SPOO1 11111

AMPLIFIES AND CONDITIONS LOW LEVEL ANALOG SIGNALS AS PART OF DATA ACQUISITION UNIT

CAPACITY.........................UP TO 33 PAIRS OF SIGNAL WIRES
OUTPUT VOLTAGE.................+-10V
OUTPUT CURRENT.................+- 5MA

DIGITAL VOLTMETER SPOO1 11111

VOLTMETER FOR DATA ACQUISITION AND CONTROL UNIT

DC VOLT RANGE............. 100MV TO 100V
AC VOLT RANGE............. 100MV TO 10V
RESOLUTION................ 0.1% FULL SCALE
ACCURACY.................. +-0.5%+-1 DIGIT

SET POINT CONTROLLER SPOO1 11111

ESTABLISHES CONTROLLER SET POINT. SET POINT CAN BE VARIED FROM PRE-PROGRAMMED INPUT

SIGNAL INPUT..................0 - 50MV
DATA OUTPUT....................1 - 50MA, 0 - 5 VDC

DIGITAL PROCESS PROGRAMMER SPOO1 11111

PERFORM PREDETERMINED LOGIC ROUTINES SUCH AS EVENT SEQUENCING, PARAMETER COMMANDS OR RELA TIME SEQUENCING.

INPUT/OUTPUT STAGE SPOO1 11111

THE INPUT/OUTPUT UNIT, THROUGH THE USE OF PLUG IN CORDS, CAN ACCOMODATE A WIDE RANGE OF PROCESS INPUTS AND OUTPUTS FOR MAXIMUM CONTROL VERSATILITY.

LOGIC LEVELS, LOGICAL "0"...... 0V
LOGICAL"1"...... 5V
SIGNAL INPUTS..................COMPATIBLE WITH PDP8 TYPE COMPUTERS
SIGNAL OUTPUTS................ 0 - 5V
DATA OUTPUTS..................12 BIT PARALLEL

CONTROL UNIT - OPERATOR SPOO1 11111

THE OPERATOR'S CONTROL PANEL WILL HAVE THE CAPABILITY OF CONTROLLING ABOUT 1000 PROCESS LOOPS. DATA MUST BE READOUT ON A QUICK-LOOK BASIS. IT MUST PROVIDE A WAY TO ENTER NEW PARAMETERS

CHANNEL NUMBER................3 DIGIT NIXIE(2 EACH)
DATA LEVEL.....................4 DIGIT NIXIE PLUS SIGN(2 EACH)
LOGIC LEVELS, LOGICAL"0"......0V
LOGICAL"1"......5V
DATA OUTPUT....................VARIABLE

PRINTER SPOO1 11111

PRINT RECORDED DATA IN THE FORM OF ALPHA-NUMERIC CHARACTERS IN HARD COPY FORM UPON REQUEST BY OPERATOR.

FORMAT .... PICA TYPE - STANDARD CHARACTERS, NUMBERS SYMBOLS

TELEPRINTER SPOO1 11111

CHARACTER ORIENTED CRT TERMINAL. DATA IN THE LINE MEMORY IS CONVERTED, BY THE CHARACTER GENERATOR, INTO THE APPROPRIATE DOT PATTERN. THE DOTS ARE SHIFTED OUT OF THE SHIFT REGISTER TO FORM A VIDEO SIGNAL TO THE MONITOR.

SCREEN FORMATS.................40,72 OR 80 CHARACTERS PER LINE
..................12 OR 24 LINES
TRANSFER RATE..................110 TO 2400 BAUD, 10 OR 11 BIT CHARACTERS
MODES..........................HALF OR FULL DUPLEX

DIGITAL TAPE RECORDER SPOO1 11111

PROVIDE DATA STORAGE FOR DIGITAL PROCESS PROGRAMMER

CHANNELS.......................15

ANALOG (SCR) CONTROLLER SPOO1 11111

SILICON CONTROL RECTIFIER EMPLOYED AS A RELAY SWITCH
LOGIC LEVELS, LOGICAL"0"......0 - 0.6V
LOGICAL"1"......3.0 - 5.0V
RANGE OF CONTROL...............0 - 100% IN 1 CYCLE INCREMENTS

MULTIPLEXER A/D CONVERTER SPOO1 11111

CONVERT INPUT SIGNAL FRO ANALOG TO DIGITAL FORMAT FOR I/O UNIT

ANALOG INPUT.............. -10.24 TO +10.235V
FULL SCALE ACCURACY...... +-0.025
RESOLUTION................ 12 BITS BINARY
CONVERSION SPEED.......... 8 KHZ
DATA OUTPUT............... 2'S COMPLEMENT

TAPE INPUT UNIT SPOO1 11111

RECIEVES,STORES,TRANSMITS DATA OF OTHER EQUIPMENT

TAPE CAPACITY..................1200FT(36CM), 0.5IN.(1.3CM) WIDE
TAPE SPEED..................... 25,18.75 AND 12.5 IN/S
......................(64,48 AND 32 CM/S)
LONG TERM VARIATION...........+-1%
DATA DENSITY...................1600 CPI (PHASE ENCODED)
......................200,556,800 CPI (NRZI)

STORAGE PERIPHERALS SPOO1 11111

THIS UNIT ACCEPTS ADDRESSED BINARY DATA FROM THE DIGITAL PROCESSOR AND TRANSLATES THIS DATA INTO EQUIVALENT ANALOG FORM.

MAXIMUM SIGNAL AND HOLD CHANNELS.32
SIGNAL AND HOLD CHANNELS PER CARD..4

AUTOMATIC PHOTOGRAPHIC PROCESSOR SPOO1 11111

UNIT PROVIDES PROCESSED HOLOGRAMS AS PART OF THE ELECTRO-OPTICAL IMAGING SYSTEM

CYCLE TIME.....................BETWEEN 5 TO 20 SEC
PLATE HOLDER SIZE..............4 IN(10CM) X 5 IN(13CM)
EFFECTIVE APERTURE AT PHOTO PLATE.....................3.25 IN.(8.5CM) X 4.0 IN (10CM)
DATA OUTPUT....................PROCESSED HOLOGRAMS

CCTV CAMERA SPOO1 11131

HIGH RESOLUTION TELEVISION CAMERA FOR VIEWING, RECORDING OR TRANSMITTING PICTURES OF MATERIAL PROCESSING EXPERIMENTS

BANDWIDTH......................32MHZ
VERTICAL SCAN LINES............1125 LINES
HORIZONTAL RESOLUTION..........1100 LINES
VERTICAL SWEEP RATE............25 OR 30 FRAMES PER SECOND
SENSITIVITY....................100 IRE UNITS OUTPUT PRODUCED WITH 0.5 FOOTCANDLE ILLUMINATION

CCTV CAMERA CONTROL UNIT SPOO1 11131

THIS UNIT WILL PERFORM THE FOLLOWING CONTROL FUNCTIONS: LENS FOCUS, LENS F STOP, CONTRAST BRIGHTNESS AND MODE. THE UNIT WILL WORK IN TWO MODES:(1)CONTINUOUS OBSERVATION MODE,WHERE ILLUMINATION IS CONTINUOUS, OR (2) PULSED OBSERVATION MODE USED WHEN ILLUMINATION IS PROVIDED BY A DYE LASER OR A NAKED FLASH LAMP.

SCANNING.......................INTERLACED 2:1, THROUGH 1125 LINES PER FRAME, 25 OR 30 FRAMES PER SECOND
HORIZONTAL SCAN FREQUENCY CONTROL..36 TO 750 HZ
VERTICAL SCAN FREQUENCY CONTROL 50 TO 60HZ

FRAME STORAGE UNIT SPOO1 11111

THE FRAME STORAGE UNIT PROVIDES NONDESTRUCTIVE READOUT, ERASE, AND STORAGE ON ELECTRONIC COMMAND AND WORKS IN EITHER CONTINUOUS OR PULSED MODE. IT PROVIDES A REAL-TIME. NO PHOTOGRAPHIC PROCESSING, HIGH SPEED, AUTOMATIC LIGHT ADJUSTMENT CAMERA CAPABLE OF PROVIDING REAL-TIME MOVIES OR FROZEN STILLS

TV MONITOR SPOO1 11111

THE MONITOR WILL DISPLAY CCTV IMAGES AS PART OF THE ELECTO-OPTICAL IMAGING SYSTEM.

SCANNING FREQUENCIES...........HORIZONTAL: 15-40 KHZ
.............VERTICAL: 15-60 FIELDS/SECOND
VERTICAL SCAN LINES............1125 LINES
LINEARITY......................1% PICTURE HEIGHT

OSCILLOSCOPE SPOO1 11111

DISPLAY OF THE PRESENCE AND/OR NATURE AND FORM OF OSCILLATIONS OR IRREGULARITIES OF AN ELECTRIC CURRENT. STORAGE CAPABILITY OF A CRT DISPLAY IS DESIRED FOR PROLONGED OBSERVATIONS.

BANDWIDTH......................DC TO 10MHZ
SENSITIVITY....................INTERNAL: 0.2CM DEFLECTION TO 1 MHZ
......................EXTERNAL: 250MV P-P TO 15V P-P
VIDEO STORAGE TIME.............1 HOUR

FLUID COOLING/REFRIGERATION UNIT SPOO1 11114

THIS UNIT MAINTAINS THE ELECTROPHORETIC SEPARATION SYSTEM, THE BUFFER SUPPLY AND SAMPLE AT A CONSTANT LOW TEMPERATURE. IT CONTROLS THE TEMPERATURE OF THE GAS ELIMINATION SYSTEM. ALSO IT COOLS (OR HEATS) THE BUFFER/SAMPLE SOLUTION(S) AND THE BUFFER USED IN THE ELECTRODE COMPARTMENTS OF THE COLUMNS.

CONTROLLED TEMPERATURE RANGE...-13F TO 113F (25 TO 45C)
TEMPERATURE ACCURACY...........+/-1.0F (+/-0.56C)
SYSTEM RECOVERY TIME...........2 MINUTES
MAXIMUM HEAT REJECTION.........2KW THERMAL

LASER OPTICAL SCATTERING MONITOR SPOO1 21111

THE LASER OPTICAL SCATTERING MONITOR WILL PROVIDE A REAL TIME MEASURE OF LIGHT SCATTERING IN A SPECIMEN AT ANYBDESIRED MEASUR-

ING ANGLE. THIS DATA WILL PROVIDE INFORMATION ON THE SIZE, SHAPE, ORIENTATION, INDEX OF REFRACTION, CONCENTRATION AND LOCATION OF OPTICAL SCATTERING CENTERS.

LASER TYPE......................LOW-POWER UV GAS DISCHARGE
FILTER BANDWIDTH...............4E-9 IN.(0.1NM) AT HALF POWER
SCATTERED LIGHT INTENSITY
ACCURACY....................0.1%
ANGULAR POSITION ACCURACY.....1 MIN (0.3MRAD)

UV-VIS SPECTROMETER SPOO1 21111

MEASUREMENT OF SAMPLE CONSTITUENTS BASED ON THE UV AND VISIBLE SPECTRUM.

RANGE .... 150 TO 1000 NM
WAVELENGTH/WAVENUMBER ACCURACY..+/- 0.1 NM FS
RESOLUTION .... 0.05 NM
RESPONSE TIME .... 2 SECONDS
SCANNING SPEED .... 0.02 TO 2.0 NM/SEC

DYE LASER/FLASH LAMP SPOO1 31111

THIS UNIT WILL BE USED FOR FREE RADICAL GENERATION, SURFACE DAMAGE THRESHOLD DETERMINATION, AND HOLOGRAPHIC MICROSCOPY

ACCURACY:
WAVELENGTH.....................0.01%
VOLTAGE OF CAPACITOR BANK.......0.1%
LASER AND FLASH LAMP ENERGY
OUTPUT.........................1.0%
SYNC. ACCURACY..................100NS
COHERENCE.......................20%
RANGE OF OPERATION:
ENERGY INPUT....................500-5000J/PULSE (.14-1.4WH/PULSE) AT LOW REPS, LARGE LAMP
....................50-500J/PULSE (.014-.14WH/PULSE) AT HIGH REPS, SMALL LAMP
ENERGY OUTPUT...................1-30J/PULSE (3E-4 - 8E-3WH/PULSE) AT LOW REPS, DYE FUND. FREQ., 250MJ TO 7J/PULSE (7E-5 - 2E-3 WH/PULSE) FREQUENCY DOUBLED.
....................100MJ TO 3J/PULSE (3E-5 TO 8E-4 WH/PULSE)AT HIGH REPS AT DYE FUNDAMENTAL, 25 - 750MJ(7E-6 - 2E-4 WH) FREQUENCY DOUBLED
REPETITION RATE.................LARGE LAMP - SINGLE TO 10/MIN
................SMALL LAMP - SINGLE TO 20HZ
FREQUENCY RANGE.................FUNDAMENTAL 430 - 750NM(1.7E-5 TO 3E-5 IN.) FREQUENCY DOUBLED 215 - 375NM (0.9E-5 TO 1.5E-5 IN.)
FLASH DURATION..................500 - 100NS
HOLOCAMERA......................35MM (1.4 IN.)
.........................SINGLE FRAME TO 20FRAMES/SEC.

FLASH LAMP SPOO1 31111

THE FLASH LAMP HAS TWO FUNCTIONAL REQUIREMENTS: (A)TO PRODUCE FREE RADICALS, AND (B)AS A PUMP SOURCE FOR EXCITING THE DYE LASER

TYPE...........................MERCURY-XENON
OPERATING TEMPERATURE..........68 TO 77F (20 TO 25C)
WAVELENGTH.....................1.2E-5 TO 2.4E-5 IN. (300-600NM)
ENERGY INPUT(MAX)..............1.5WH (5KJ)
(MIN)..............0.3WH (1KJ)

RETROCONSTRUCTION HIGH RESOLUTION HOLOMICROSCOPE SPOO1 31235

DIALYSIS UNIT SPOO1 11113

METERING PUMPS SPOO1 11111

BUFFER AND SPECIMEN METERING PUMPS FOR CONTINUOUS FLOW ELECTROPHORETIC COLUMN

FLOW RATE-........... .007ML/MIN TO 30ML/MIN
PRESSURE HEAD........ 4E04 - 5.6 TO 14 PSI(4E04 - 10E04N/M2)
REPRODUCIBILITY...... +-0.5%

CONTINUOUS FLOW ELECTROPHORETIC COLUMN WITH PUMP SPOO1 11114

THIS UNIT SEPARATES BIOLOGICAL SAMPLES BY ELECTROPHORESIS. RELATIVELY LARGE SAMPLES, APPROXIMATELY 10 CC, WILL BE PROCESSED. SAMPLE AND BUFFER FLOW WILL BE CONSTANT AND SAMPLE FRACTION COLLECTION CONTINUOUS.

TOTAL BUFFER AND SAMPLE VOLUME.. 60CU.IN. (1000CC)
OPERATING TEMPERATURE.......... 14 TO 41 F(-10 TO 5C)
OPERATING TEMPERATURE REGULATION +/-2F (+/-1C)
SEPARATION PROFILE ACCURACY... +/-.004IN(+/-.1MM)
POSITION MONITOR ACCURACY..... +/-.004IN(+/-.1MM)
FRACTION OUTLET PORT LOCATION ACCURACY +/-.004IN(+/-.1MM)
INPUT VOLTAGE................. 5000V

STATIONARY ELECTROPHORETIC COLUMNS SPOO1 11114

THE STATIONARY ELECTROPHORETIC COLUMNS HAVE TWO ANTICIPATED USAGES: (A)TO ESTABLISH PROCESSING AND OPERATING PARAMETERS FOR THE CONTINUOUS ELECTRORETIC COLUMNS, AND (B) FOR SMALL BATCH PROCESSING (APPROXIMATELY 0.1CC(.006 IN**3)) OF VARIOUS BIOLOGICAL COMPONENTS

TOTAL BUFFER AND SAMPLE VOLUME 1.5CU.IN. (25CC)
SEPARATION VELOCITY ACCURACY.. +/-0.04IN (+/-1MM)
POSITION MONITOR ACCURACY..... +/-0.04IN (+/-1MM)
OPERATING TEMPERATURE RANGE... 14 TO 41F (-10 TO 5C)
TEMPERATURE TOLERANCE......... +/-2F (+/-1C)

GAS ELIMINATION SYSTEM SPOO1 11114

REMOVES GASSES PRODUCED BY ELECTROLYSIS IN THE ELECTRODE COMPARTMENTS OF THE ELECTROPHORETIC COLUMNS

OUTLET OXYGEN CONCENTRATION... 3% (BY VOLUME)
OUTLET HYDROGEN CONCENTRATION. 2% (BY VOLUME)
MAX FLOW RATE................. TBD
FLOW RATE CONSTANCY........... +-1%
OPERATING TEMPERATURE......... 68 - 77 F (20 - 25 C)

BUFFER AND ELECTROLYTE SUPPLY TANKS SPOO1 11112

PH MONITOR SPOO1 21111

MEASURE ACIDITY AND ALKALINITY OF SOLUTIONS. USED IN OP LAB ALSO

PH RANGE...................... 4.2 TO 12
SELECTABLE RANGES............. ANY 2
.... ANY 5
.... ANY 10
READING STABILITY............. 0.02 PH
LIQUID TEMPERATURE RANGE...... 32 TO 212 F (0 TO 100 C)

FRACTION COLLECTION SYSTEM SPOO1 11235

THIS APPARATUS WILL HAVE TWO FUNCTIONS: (1) TO COLLECT THE DESIRED FRACTIONS AFTER SEPARATION, AND (2) TO REMOVE THE EXCESS BUFFER SOLUTION AND REMAINING UNWANTED SAMPLES

PUMP TYPE......................POSITIVE DISPLACEMENT
1.8 CU.IN/MIN (30 CC/MIN)
PUMPING RATE ACCURACY.......+-0.1%
ALLOWABLE PUMP PULSATION......0.01PSI (+/-70 N/M2)
TEMPERATURE REGULATION........+/-1.0F (+/-0.5C)

FLOW METER SPOO1 11111

GAS FLOW METERING AND MONITORING DEVICE.

GAS TYPE .... OXYGEN, NITROGEN, HELIUM
GAS FLOW RATE .... 0.4 TO 0.3 LB/HR
0.3 TO 3.0 LB/HR

LYOPHILIZATION UNIT SPOO1 11111

RECIRCULATING FLUID INCUBATOR SPOO1 11112

DISSOLVED OXYGEN ANALYZER SPOO1 11111

THE UNIT WILL DETERMINE THE AMOUNT OF DISSOLVED OXYGEN PRESENT IN THE ELECTROLYTE AFTER IT HAS BEEN PROCESSED THROUGH THE GAS ELIMINATION SYSTEM. IT WILL MONITOR OXYGEN DURING A REACTION EXPERIMENT IT WILL ALSO FUNCTION AS A GASEOUS OXYGEN MONITOR

CONCENTRATION RANGE........... 0 TO TOTAL OXYGEN SATURATION
ACCURACY...................... +-1%
RESPONCE TIME................. 90% ACTUAL IN 10SECONDS
SAMPLE TEMPERATURE RANGE...... 32 TO 110F (0 TO 43C)

SPECIMEN/SAMPLE SUPPLY TANKS SPOO1 11113

HIGH VOLTAGE POWER CONDITIONER SPOO1 11112

PROVIDES DC VOLTAGE TO EITHER THE STATIONARY OR CONTINUOUS FLOW ELECTROPHORETIC COLUMNS. REGULATION MUST REMAIN CONSTANT OVER A RELATIVELY LARGE CURRENT DEMAND.

OUTPUT VOLTAGE REGULATION.....+-0.1%
VOLTAGE RANGE.................25 TO 2500 VDC
READOUTS......................VOLTAGE LEVEL
POWER OUTPUT TO COLUMNS.......20W SUSTAINED
200W PEAK

DARK FIELD ILLUMINATOR SPOO1 21111

REFRIGERATOR SPOO1 11111

THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES

TEMPERATURE...................32 - 68F (0 - 20C)
LENGTH........................2FT (60CM)
WIDTH.........................1.8FT (54CM)
HEIGHT........................2.8FT (84CM)

FREEZER SPOO1 11111

THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES

CONTROLLED TEMPERATURE RANGE..-13F TO 113F (-25C TO 45C)
LENGTH........................1FT (30CM)
WIDTH.........................1.8FT (54CM)
HEIGHT........................2.8FT (84CM)

DEWAR SPOO1 11111

THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES

TEMPERATURE...................-112F (-80C)
LENGTH........................1FT (30CM)
WIDTH 1.8FT (54CM)
HEIGHT........................2.8FT (84CM)

WASTE LIQUID TANK SPOO1 11113

MOLECULAR SIEVE SPOO1 41133

THE MOLECULAR SIEVE IS USED TO CLEAN GASSES GENERATED IN FURNACES AND EXHAUSTED TO SPACE. THIS UNIT IS ALSO USED IN THE FURNACE, GENERAL PURPOSE AND LEVITATION SUBELEMENTS

COOLANT SUPPLY TANK SPOO1 11113

ISOELECTRIC FOCUSING UNIT SPOO1 11114

HOT WALL TUBE FURNACE SPOO2 31111

THIS UNIT IS A GENERAL PURPOSE,HOT WALL HEATING DEVICE

PROVIDING ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH RESPECT TO A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.

VACUUM LEVEL....................2E-8 PSI (1.5E-4N/M2)
OPERATING TEMPERATURE..........2200F (1200C)
MAX EXTERNAL SURFACE TEMP.....110F (45C)
HOT ZONE DIMENSIONS............2.5 IN (6CM) DIA. X 6IN(15CM)LNG
MAXIMUM DEVIATION FROM FLAT
PROFILE.......................+/-4F (+/-2C)

HOT WALL FURNACE SPOO2 21111

THIS UNIT IS A GENERAL PURPOSE, HOT WALL HEATING DEVICE PROVIDING ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH RESPECT TO A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.

VACUUM LEVEL....................2E-8 PSI (1.5E-4N/M2)
OPERATING TEMPERATURE..........3300F (1800C)
EXTERNAL SURFACE TEMPERATURE..110F (45C)
HOT ZONE DIMENSIONS(MIN)......1IN. (2.5CM)DIA.X5IN.(13CM)LONG
MAXIMUM DEVIATION FROM FLAT
PROFILE....................+/-7F (+/-4C)
VIEWPORTS......................2

CHEST-GENERAL PURPOSE ENCLOSURE SPOO2 31113

THE PRIMARY FUNCTION OF THE ENCLOSURE IS TO ISOLATE THE HEATED SPECIMEN FROM THE LABORATORY ENVIRONMENT, BOTH THERMALLY AND ATMOSPHERICALLY, AND TO PROVIDE A MEANS TO STRUCTURALLY ATTACH THE VARIOUS HEATING ELEMENTS AND ACCESSORY ITEMS

VACUUM LEVEL....................2E-10PSI (1.5E-6N/M2)
MAXIMUM INTERNAL TEMP..........5400F (3000C)
MAX EXTERNAL SURFACE TEMP.....110F (45C)
HOT ZONE DIMENSIONS(MIN)......1IN.(2.5CM)DIA.X4IN(10CM) LONG
FULL LENGTH FRONT OPENING DOOR
VIEW PORTS.....................FRONT,REAR,2 SIDES,BOTTOM,TOP
FLANGE OPENINGS................TOP,BOTTOM,2 EACH SIDE,2 REAR

DIRECTIONAL SOLIDIFICATION UNIT SPOO2 11114

THIS UNIT CONSISTS OF A FURNACE AND A CHILL UNIT. SPECIMENS ARE HEATED, MOVED THROUGH A THERMAL GRADIENT AREA AND THEN INTO A COOLING AREA.

CHILL UNIT DIMENSIONS..........0.6 IN(1.5CM)I.D.X8.0 IN(20CM) LONG
CHILL CAPACITY..................1KW THERMAL
HEATING UNIT DIMENSIONS........0.8 IN(2CM)I.D.X8IN(20CM) LONG
HEATER CAPACITY.................1KW THERMAL
TEMPERATURE GRADIENT ADJUST
RANGE....................9 TO 900F/IN (2 TO 200C/CM)
HEATER MAX TEMPERATURE.........2900F(1600C)
CHILL UNIT MIN TEMP............68 TO 77F (20 TO 25C)
EXTERNAL SURFACE TEMP..........60 TO 110F (15 TO 50C)

ACOUSTIC MIXING AND DISPERSAL UNIT SPOO2 21235

ELECTROMAGNETIC MIXING AND DISPERSAL UNIT SPOO2 21235

IR PYROMETER SPOO2 21111

THE PYROMETER OPTICALLY SENSES THE INTENSITY OF RADIANT ENERGY EMITTED FROM THE SAMPLE SURFACE

TEMPERATURE RANGE .... 104 TO 5400 F (40 TO 3000 C)
SPECTRAL RESPONSE..............0.70 - 0.97 MICROMETERS
CALIBRATION ACCURACY...........+-1% FULL SCALE
REPEATABILITY...................+-3% FULL SCALE

ZONE REFINER SPOO2 11112

THIS UNIT WILL HEAT, HOLD AND MANIPULATE A SPECIMEN FOR ZONE REFINING AND MOLTEN ZONE CRYSTAL GROWTH. IT WILL CAUSE A MOLTEN REGION TO TRAVERSE ALONG A LONG CYLINDRICAL ROD OF MATERIAL.

SPECIMEN SIZE....................4 TO 12 IN (10 TO 30 CM) LONG
0.1 TO 0.5IN(0.25 TO 1.25CM) DIA
SCANNING DISTANCES.............UP TO 12IN(30CM)
SCANNING SPEED..................UP TO 20IN/MIN (50CM/MIN)
SPECIMEN ROTATION..............0 TO 60 RPM
OPERATING TEMPERATURE..........575 TO 2900F (300 TO 1600C)

FEED AND CRYSTAL HOLDER SPOO2 21113

RESIDUAL GAS ANALYZER SPOO2 21111

IDENTIFY TYPE AND QUANTITY OF GAS REMAINING IN A PROCESSING CHAMBER OR GENERATED DURING A PROCESS. THE ANALYZER IS ALSO USED IN THE LEVITATION SUBELEMENT. THE UNIT MUST HAVE A TUNABLE MASS UNIT SECTION FOR LEAK DETECTION, BE A QUADROUPOLE TYPE INSTRUMENT CAPABLE OF SEPARATING MASSES. THE INSTRUMENT MUST ACT AS A PARTIAL AND TOTAL PRESSURE ANALYZER AS WELL AS GAS ANALYZER.

MASS RANGE RESOLUTION.......... UP TO 200AMU
DETAILED SPECTRAL ANAL MASS RANGES....1-50 AND 40-65AMU
SCOPE SCAN SPEED................ VARIABLE 3MS TO 300S
DATA OUTPUT..................... VISUAL ANALOG
ANALOG
DIGITAL
USEFUL PRESSURE RANGE..........1.0E-5 PSI(7.5E-2N/M2)
TO 1.0E-11 PSI (7.5E-8N/M2)
MASS SEPARATION CAPABILITY.... 1AMU
MIN DETECTABLE PARTIAL PRESSURE..2E-12 PSI (1.5E-8N/M2)
MIN DETECTABLE TOTAL PRESSURE.......1E-10 PSI (7.5E-7N/M2)

RF INDUCTION PWR COND. (MIXING & DISPERSAL) SPOO2 21111

LOW VOLT/HIGH AMP POWER CONDITIONER (10KW) SPOO2 31111

TWO - COLOR PYROMETER SPOO2 21111

RESISTANCE HEATER (CONTACT) SPOO2 21111

HEATING ELEMENT WHICH HEATS ENCAPSULATED SAMPLES BY PASSING A CURRENT THROUGH IT

POWER..........................4KW SUSTAINED, 9KW PEAK
TEMPERATURE(MAX)...............2900F (1600C)
ATMOSPHERE.....................INERT GAS OR VACUUM

MICROWAVE HEATER SPOO2 31235

PROVIDE MICROWAVE ENERGY SOURCE FOR SPECIMEN HEATING

TEMPERATURE(MAX)...............18000F (10,000C)
POWER(MAX).....................2KW
FREQUENCY RANGE(MAX)...........UP TO 1E10 HZ
OPERATIONAL ATMOSPHERE.........ANY BUT VACUUM

GRADIENT FURNACE SPOO2 11113

MECHANICAL MIXING AND DISPERSAL UNIT SPOO2 11235

THREE AXIS MANIPULATOR SPOO2 21132

PIEZOELECTRIC DRIVE SPOO2 21114

VACUUM/PRESSURE REGULATOR SPOO2 31111

THE UNIT REGULATES THE PRESSURE IN THE PROCESSING CHAMBERS BY ADMITTING FLUID FROM A FLUID SUPPLY CONTAINER. THIS UNIT IS ALSO EMPLOYED ON THE GENERAL PURPOSE AND LEVITATION SUBELEMENTS

PRESSURE-ABSOLUTE .... 0.1 TO 1000 PSIA

HIGH VACUUM PUMP SPOO2 21111

UNIT IS USED IN CONCERT WITH MOLECULAR SIEVE. IT IS USED WITH THE SPACE VACUUM TO BLEED DOWN OVENS. THIS UNIT IS ALSO USED ON THE LEVITATION SUBELEMENT.

PRESSURE-ABSOLUTE .... AMBIENT TO 0.1 PSIA

VACUUM/PRESSURE MEASUREMENT UNIT SPOO2 31111

MEASURES PRESSURES IN PROCESS CHAMBERS. UNIT IS ALSO REQUIRED FOR GENERAL PURPOSE AND LEVITATION SUBELEMENTS.

PRESSURE-ABSOLUTE .... AMBIENT TO 0.01 PSIA

HIGH VOLTAGE POWER CONDITIONER (17KV) SPOO2 31111

RF INDUCTION POWER CONDITIONER (2KHZ - 2MHZ) SPOO2 21111

THERMAL OVEN SPOO3 21111

IR SPECTROMETER SPOO3 11111

INFRARED ANALYSIS OF CONSTITUENTS IN GASEOUS OR LIQUID STREAMS.

RANGE .... 10 TO 100 MICRONS
RESOLUTION .... +/- 0.5 MICRONS
RESPONSE TIME .... 2 SECONDS

LASER PYROMETER SPOO3 21235

GAS CHROMATOGRAPH SPOO3 21111

THE FUNCTIONAL REQUIREMENTS OF THE EQUIPMENT ARE TO ANALYZE THE ATMOSPHERIC COMPOSITION AND THE IMPURITY CONCENTRATION CONTAINED WITHIN THE EXPERIMENTS' EQUIPMENT ENCLOSURES. THIS ELEMENT IS ALSO USED ON THE LEVITATION SUBELEMENT.

FLOW RATE .... 10 ML/MINUTE
SENSITIVITY..................... 0.1 PPM

TIME LAPSE HIGH SPEED CAMERA SPOO1 21111

CAMERA ALSO USED IN LEVITATION SUBELEMENT

NUCLEAR PARTICLE COUNTING UNIT SPOO1 11111

CAPABILITY TO DISCRIMINATE AND COUNT ALPHA, BETA, GAMMA, X-RAYS AND K-ELECTRONS.

COUNTING RATE .... 3.5E+06 C/M
RESOLUTION LOSS .... 1 %/3E+06 C/M
PLATEAU CHARACTER
ALPHA .... 500-1200 V @ 1 %/100V
BETA-GAMMA .... 1200-1900 V @ 1 %/100 V
PRECISION .... +/- 0.1 % FS
TIMER .... 0.05 TO 2160 MINUTES

RESISTANCE THERMOMETER SPOO3 N1111

THERMOCOUPLES SPOO3 N1111

RESISTANCE HEATER (NON-CONTACT) SPOO4 11111

TUBE TYPE HEATING UNIT FOR USE IN CHEST-GENERAL PURPOSE ENCLOSURE OR HOT WALL FURNACE

POWER..........................4KW SUSTAINED, 9KW PEAK
TEMPERATURE(MAX)...............2900F (1600C)
SPECIMEN SIZE..................4IN (10CM)LONG X 0.75 IN(2CM) DIA.

RF INDUCTION COILS SPOO4 11111

PROVIDE NON-CONTACT HEATING

FREQUENCY RANGE................2KHZ TO 2MHZ
OPERATIONAL ATMOSPHERE.........ANY

ELECTRON BEAM SOURCE SPOO4 11114

THE ELECTRON BEAM SOURCE WILL BE USED TO HEAT SAMPLES THAT REQUIRE NON-CONTACT HEATING. THE UNIT WILL BE USED IN THE CHEST-GENERAL PURPOSE ENCLOSURE

DELIVERABLE POWER..............3 - 4 KW
INPUT POWER....................6KW
TEMPERATURE....................4500F (2500C)
MAXIMUM SAMPLE SIZE............0.15 CU.IN. (2CC)
OPERATING PRESSURE.............1E-10 PSI (7.5E-7N/M2)

LASER SOURCE SPOC4 11111

PROVIDE HEAT TRANSMITTED TO A SPECIMEN BY LASER BEAM. CONCEPT PROVIDES HEATING WITHOUT CONTAMINATING SPECIMEN. UNIT IS USED IN CONJUNCTION WITH CHEST-GENERAL PURPOSE ENCLOSURE

POWER..........................6KW
COOLING CAPACITY...............7.5KW
LASER TYPE.....................ANY OF FOLLOWING FIVE:
.......................CONTINUOUS WAVE HYDROGEN-FLOURINE CHEMICAL LASER, IR OUTPUT
.......................CONTINUOUS WAVE FORCED CONVECTION CO2, IR OUTPUT
.......................CONTINUOUS WAVE CO-C2-H2O-HE CHEMICAL LASER, IR OUTPUT
.......................PULSED TEA CO2, IR OUTPUT
.......................PULSED TEA XENON, UV OUTPUT

MINIMUM B WITH RF HEATING SPOO4 11235

ELECTROMAGNETIC POSITIONING COILS AND DETECTOR SPOO4 11115

PROVIDE ALTERNATING ELECTROMAGNETIC FIELD FOR CONTACTLESS POSITION CONTROL.

MAGNETIC PRESSURE .... 1.4 PSI (10 KN/SQ M)

ELECTROSTATIC POSITIONING PROBES AND DETECTOR SPOO4 11115

ELECTROSTATIC FIELDS USED FOR POSITIONING EXPERIMENT SPECIMEN SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.

CHAMBER PRESSURE .... > 0.14 PSI (1 KN/SQ M)
< 2E-06 PSI (0.01 N/SQ M)

CONFIGURATION .... IN APEX OF TETRAHEDRON

ACCUSTIC TRANSDUCER AND DETECTOR. SPOC4 11111

USE OF SOUND PRESSURE WAVES TO POSITION EXPERIMENT SPECIMEN SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.

CHAMBER PRESSURE .... > 0.14 PSI
(1 KN/SQ M)
< 2E-06 PSI
(0.01 N/SQ M)
CONFIGURATION .... IN APEX OF TETRAHEDRON

GAS JET POSITIONING PROBES AND DETECTORS SPOC4 11115

USE OF GAS JETS TO POSITION SPECIMEN DURING EXPERIMENT PROCEDURES SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.

GAS FILTER .... 8E-06 INCHES (0.2 MICROMETERS)
GASES .... HELIUM, HYDROGEN, OXYGEN
CONFIGURATION .... JET PAIR IN APEX OF TETRAHEDRON
GAS PRESSURE MINIMUM .... 0.014 PSIA (100 N/SQ M)

DIRECTIONAL CALORIMETER SPOC4 11113

THE DIRECTIONAL CALORIMETER WILL BE COMPOSED OF A PYROELECTRIC IR DETECTOR, DETECTOR PREAMPLIFIER, OPTICAL MODULATOR (LIGHT CHOPPER) AND DEMODULATOR (RECTIFIER). IT WILL BE USED TO DETERMINE THE BEGINNING OF SOLIDIFICATION BY OBSERVING THE ACCOMPANYING THERMAL ARREST AND WILL MEASURE THE RATE OF RELEASE OF THE HEAT OF FUSION.

PYRCLYTIC IR DETECTOR SPECTRAL
RANGE..........................2E-5 TO 3E-3 IN(0.5 TO 75 MICROMETERS)
INCIDENT FLUX RANGE............6.5W/IN2 (1 - 10W/CM2)

MECHANICAL SAMPLE PLACEMENT AND RETRIEVAL SPOO4 11113

LIQUID SYRINGE DISPENSER SPOC4 21113

INERTIAL INJECTOR SPOO4 11235

VACUUM CATCH TUBE SPOO4 11235

SOLID SAMPLE STORAGE SPOO4 11112

LIFE SCIENCES

CAMERA - STILL FILM (CORE) LS988 11111

STILL PHOTOGRAPHIC CAPABILITY WHICH IS SHARED WITH OTHER EXPERIMENTS. CAMERA HAS INTERCHANGEABLE LENS AND IS COMPATIBLE WITH EQUIPMENT SUCH AS MICROSCOPES AND OSCILLOSCOPES.

FILM FORMAT .... 35 MM
LENS .... 58 MM, F1.2
VIEW ANGLE .... 41 DEGREES
LENS .... 35 MM, F1.8
VIEW ANGLE .... 64 DEGREES
SHUTTER SPEED .... 8 TO 1/500 SEC
VIEWING .... THRU LENS
FOCUS .... SPLIT IMAGE

CAMERA - STILL POLAROID (CORE) LS002 41111

POLAROID PHOTOGRAPHIC CAPABILITY SHARED WITH MOST EXPERIMENTS ALSO ADAPTABLE WITH MICROSCOPE AND OSCILLOSCOPE INTERFACES.

FILM FORMAT .... POLAROID 107 BLACK/WHITE
.... 3.25X4.25 IN (82.55X192.95 MM)
LENS .... 50 MM, F3.5 TO F22
SHUTTER SPEEDS .... 8 TO 1/60 SEC.
RANGE FINDER .... SPLIT IMAGE
VIEWING .... THRU LENS
FIELD OF VIEW .... 40 DEGREES

RECORDER - STRIP CHART (CORE) LS1013 11111

HARD RECORD OF APPROPRIATE LIFE SCIENCES DATA.

FREQUENCY RESPONSE .... DC TO 150 HZ
SENSITIVITY .... 0.1 TO 50 MV/MM
CHANNELS 8
CHART SPEED .... 1 TO 500 MM/SEC
WRITING METHOD .... THERMAL

OSCILLOSCOPE - PERSISTENT CRT (CORE) LS976 11111

ELECTRONIC MONITOR AND DATA MEASUREMENT CAPABILITY OF LIFE SCIENCE EXPERIMENT EQUIPMENT WITH A SCREEN HAVING LONG TERM RETENTION.

BANDWIDTH .... DC TO 5 MHZ (MINIMUM)
CHANNELS 2
DEFLECTION FACTOR .... 1 MV TO 10 V PER DIVISION
PHOTOGRAPHIC CAPABILITY .... YES
PERSISTENCE .... UP TO 6 HOURS

MICROSCOPE, DISSECTING LS1004 11111

PERMIT DETAIL DISSECTING OF BIOLOGICAL SPECIMENS SUCH AS PLANTS, ANIMAL TISSUE AND ORGANS

STEREO EYEPIECE
ADJUSTABLE BRIGHT AND DARK FIELD ILLUMINATION

MICROSCOPE, COMPOUND LS1005 11111

GENERAL PURPOSE BINOCULAR MICROSCOPE FOR MICROSCOPIC STUDIES OF TISSUES

MAGNIFICATION.................. 10X TO 100X
PHOTOGRAPHIC CAPABILITY........ POLAROID FILM
LIGHTING....................... DARK FIELD OR LIGHT FIELD AND PHASE CONTROL

RECORDER - VOICE (CORE) LS1006 11111

CAPABILITY OF RECORDING ORAL COMMENTS.

CHANNELS 4
BANDWIDTH .... 50 TO 20000 HZ

MICRODISSECTION TOOL KIT LS998 11111

STANDARD MEDICAL MICRODISSECTION KIT

MICROTOME (CORE) LS021 11111

CAPABILITY TO THINLY SLICE EXPERIMENT SPECIMEN.

SECTIONING .... 1 TO 50 MICROMETERS

CRYOSTAT (CORE) LS022 11111

CAPABILITY OF STORING QUANTITIES OF CRYOGENIC LIQUID

QUANTITY .... 5 GALLONS (0.0019 CU M)
TEMPERATURE .... -319 F (-195 C)

VETERNARY MEDICAL KIT (CORE) LS997 11111

INCLUDES OTOSCOPE/OPTHALMOSCOPE, REFLEX HAMMER, HEMOGLOBINOMETER, TOURNIQUET, SYRINGES, NEEDLES, SCALPELS, HEMOSTATS, TWEEZERS, AND OTHER STANDARD ITEMS.

OVEN LS027 21111

CAPABILITY TO HEAT, MAINTAIN CONSTANT TEMPERATURE, AND DRY TEST EQUIPMENT, LIQUIDS AND TEST SPECIMEN.

TEMPERATURE RANGE .... 32 TO 450 F (0 TO 233 C)
CAPACITY .... 1 CU FT (0.03 CU M)

HISTOLOGY KIT/SLICE CABINET (CORE) LS996 11111

STANDARD KIT CONTAINING PROBES, KNIVES, NEEDLES, SYRINGES, COVER SLIPS, LADLES PLUS OTHER NORMALLY INCLUDED ITEMS.

CONSTANT TEMPERATURE BLOCK (CORE) LS1015 21111

HEAT SINK MAINTAINING A CONSTANT TEMPERATURE FOR TEST TUBES AND VIALS.

TEMPERATURE .... 248+/-1.0 F (120+/-0.5 C)

SPECTROPHOTOMETE IR (CORE) LS032 11111

PERFORM SPECTROPHOTOMETER ANALYSIS OF LIFE SCIENCES SPECIMEN IN THE INFRARED RANGE .

SPECTRAL RANGE .... 2.5 TO 12 MICROMETERS
RESOLUTION .... 0.1 PERCENT OF WAVELENGTH
SCAN TIME .... 5 SEC TO 50 HOUR
SAMPLE TEMPERATURE .... AMBIENT TO 482 F (250 C)

GAS ANALYZER, AUTOMATIC LS993 11111

DETERMINE THE PARTIAL PRESSURES OF OXYGEN AND CARBON DIOXIDE DISSOLVED IN BLOOD SAMPLES AND TO DETERMINE THE HYDROGEN ION CONCENTRATION

(REQUIREMENTS UNSPECIFIED. COMMERCIAL UNIT USED AS MODEL)
PH............................. 6.000 TO 8.000
CO2 PARTIAL PRESSURE........... 0 TO 200MM HG
O2 PARTIAL PRESSURE............ 0 TO 2000MM HG
ACCURACY:
PH............................. +/-0.003P
CO2 PARTIAL PRESSURE........... +/-0.5PM
O2 PARTIAL PRESSURE............ +/-1MM HG AT 200 PO2
+/-10MM HG AT 2000 PO2

URINE ANALYZER - AUTOMATIC (CORE) LS984 11111

CAPABILITY TO AUTOMATICALLY PERFORM URINE ANALYSES.

MASS SPECTROMETER LS994 11111

PROVIDE ANALYSIS OF UNKNOWN IONIZED GAS BY ATOMIC MASS NUMBER.

MASS RANGE..................... 1 TO 400AMU
SCANNING RANGE................. VARIABLE
VARIABLE SCANNING RATE......... 50 MILLISECOND TO 600 SEC/SCAN
MAX OPERATING PRESSURE......... 1E-4TORR
SELECTABLE CENTER MASS
SELECTABLE SCANNING WIDTH

PH METER LS1016 11111

METER MEASURES HYDROGEN ION CONCENTRATION OF SOLUTIONS

PH RANGE....................... 0 - 14
MEASUREMENT ACCURACY........... 0.02PH

ULTRASONIC CLEANER (CORE) LS047 11111

HIGH FREQUENCY ENERGY FOR CLEANING EXPERIMENT AND MAINTENANCE EQUIPMENT.

OPERATING FREQUENCY .... 20000 HZ
CAPACITY .... 1 CU FT

VOLTOHM METER LS1012 11111

PORTABLE RELIABLE MULTI-FUNCTION METER FOR GENERAL PURPOSE EXPERIMENTAL WORK AND TROUBLE SHOOTING.

DC VOLTS .... 100 MV TO 10 KV
DC CURRENT .... 1 MA TO 10 AMPS
AC VOLTS .... 10 MV TO 300 VOLTS
AC CURRENT .... 1 MA TO 1 AMP
OHMMETER .... 10 OHMS TO 10 MOHMS

SIGNAL GENERATOR LS052 11111

ACCURATELY REPRODUCE SELECTED FREQUENCIES AS REFERENCES FOR PURPOSES OF MAINTENANCE AND REPAIR.

BANDWIDTH .... DC TO 20 KHZ
OUTPUT VOLTAGE .... 3 V TO 0.1 MV

PLETHYSMOGRAPH, LIMB(INCLUDING COUPLER) LS1013 11111

MEASURE CHANGES IN BLOOD VOLUME AND VASCULAR RESPONCES

MEASUREMENT RANGE.............. HIGH RANGE-15 TO 500 OHMS
LOW RANGE-1.5 TO 50 OHMS

ACCELEROMETER - SPECIMEN MOVEMENT LS901 121111

ORGANISM CONTAINER ACTIVITY AND ACTIVITY LEVEL MONITOR.

ACCURACY .... +/- 0.0004 G
FREQUENCY RESPONSE .... 0 TO 100 HZ

AUDIOMETER LS902 11111

FREQUENCY SOURCE ADJUST IN BOTH FREQUENCY AND AMPLITUDE FOR EARPHONES OR BONE VIBRATORS

FREQUENCY...................... 125 TO 8000 ADJUSTIBLE IN OCTAVES
ATTENUATOR..................... CONTINUOUSLY ADJUSTIBLE IN 1DB STEPS

ANALYZER - ATOMIC ABSORPTION SPECTROPHOTOMETER LS903 11111

QUANTITATIVE DETERMINATION OF METALLIC AND SEMIMETALIC ELEMENTS IN SOLUTIONS AND INDICATING CONCENTRATION.

WAVELENGTH RANGE .... 200 TO 800 MILLIMICRONS
MODES OF OPERATION .... ATOMIC ABSORPTION, FLAME EMISSION, UV-VISIBLE SPECTROPHOTOMETRY
COUNTER ACCURACY .... +/- 0.4 NANOMETERS

ORIGINAL PAGE IS OF POOR QUALITY

Space Division
Rockwell International

CELL COUNTER - BLOOD LS907 11111

MEASURE BLOOD CELL PROPERTIES OF BLOOD SAMPLES. ESSENTIALLY A COULTER COUNTER

PARAMETERS MEASURED ....HEMOGLOBIN,HEMATOCRIT,RED BLOOD CELL COUNT,WHITE BLOOD CELL COUNT,MEAN CELL VOLUME,MEAN CELL HEMOGLOBIN AND MEAN CELL HEMOGLOBIN CONCENTRATION
REPRODUCIBILITY...............+/-1%

BACTERIAL COLONY COUNTER LS908 11111

MANUAL COUNT OF BACTERIAL COLONIES. UNIT IS STANDARD TYPE

DIGITAL PLOTTER, PRINTER LS909 11111

KEYBOARD LS910 11111

TYPEWRITER TYPE KEYBOARD USED FOR PROVIDING INSTRUCTIONS FOR THE COMPUTER

ELECTROPHYSIOLOGY BACKPACK LS912 11235

BACKPACK CONTAINS THE NECESSARY ELECTRONICS FOR SENSING AND TRANSMITTING MAN'S PHYSIOLOGICAL DATA SUCH AS ECG, EEG, EMG, EOG, ETC. INCLUDES SENSORS, SIGNAL CONDITIONERS, MULTIPLEXERS, A/D CONVERTERS AND TRANSMITTERS

ELECTROPHYSIOLOGY RECEIVER LS913 11111

PROVIDE SPECIAL RECEPTION OF CARDIOVASCULAR AND NEURAL ELECTRO-PHYSIOLOGICAL EVENTS VIA BIOTELEMETRY SYSTEMS

SIGNAL TYPES RECEIVED..........ELECTROENCEPHALOGRAM
..........ELECTROCARDIOGRAM
..........VECTORCARDIOGRAPHY
..........BALISTOCARDIOGRAPHY
..........IMPEDANCE CARDIOGRAPHY
..........PHONOCARDIOGRAPHY

BLOOD CLOT FIBROMETER LS915 11111

PROVIDE AUTOMATIC MEASUREMENT OF PLASMA COAGULATION TIME

ACCURACY.......................+/-0.1SECOND

FREEZER, CRYOGENIC LS916 11111

PROVIDE A MEANS FOR FREEZING AND STORING BIOLOGICAL SPECIMENS

STORAGE CAPACITY...............115 CU.IN. (1.89LITERS)
OPERATING TEMPERATURE..........-320F(78K)
MIN CRYOGEN HOLDING TIME.......3 WEEKS BETWEEN REFILLS

HEMATOCRIT, ELECTRONIC LS917 11111

AUTOMATICALLY DETERMINE THE PERCENT HEMOCRIT IN BLOOD. RAPID % READOUT AND TEMPERATURE COMPENSATOR REQUIRED

DOSIMETER, RADIATION DETECTOR LS918 11111

PORTABLE DEVICE WHICH WILL ALERT USER TO RADIATION LEVELS IN EXCESS OF A PREDETERMINED LEVEL AND TO PROVIDE A DIRECT READOUT OF THE TOTAL CUMULATIVE RADIATION DOSE.

RATE MEASUREMENT RANGE .... 0 TO 0.1 MR/HR
0 TO 50 R/HR
ADJUSTABLE RADIATION ALARM ... 0.05 MR/HR TO 50 R/HR
CUMULATIVE DOSAGE RANGES ...... 0 TO 200 MR
0 TO 500 R
ACCURACY (X- & GAMMA RAY) .... +/- 10 %

RADIATION DETECTOR LS919 11111

ACCURATE MEASUREMENT OF EITHER ALPHA, BETA, GAMMA, X-RAY OR NEUTRON RADIATION AS IT IS APPLIED TO A BIOLOGICAL SPECIMEN.

RATE RANGES .... 0 TO 0.1 MR/HR
0 TO 1000 R/HR
CALIBRATED READOUTS .... COUNTS/SEC, /MIN, AND TOTAL

ISOTOPE SOURCE -SELF CONTAINED LS920 11111

RADIATION STRESS SOURCE USED IN CONDUCTING RED BLOOD CELL SURVIVAL STUDIES. TYPICAL ASSORTMENT - NITROGEN 15 COMPOUNDS, RADIOLABELED SUBCELLULAR PRODUCTS (RIBOSOMES), RADIOLABELED POLY-NUCLEOTIDES OR TITRATED THYMIDINE.

RADIATION LEVEL .... 1 TO 100 MICROCURIE

BIOTELEMETRY RECEIVER - COMPACT CAGE MODULE LS921 121113

MICROBACKPACKS FOR SMALL VERTEBRATE ACQUIRING AND TRANSMITTING BIO DATA.

SIGNAL CONDITIONER LS922 11111

ELECTRICAL SIGNAL TRANSFORMATION BETWEEN ANY NUMBER OF TRANS-DUCERS AND MULTIPLEXER/ANALOG TO DIGITAL CONVERTER

COMPUTER INPUT .... +/- 10 VOLTS

SOUND LEVEL METER LS923 11111

SOUND LEVEL SURVEYS AND LIMITED FREQUENCY ANALYSIS IN REAL TIME.

FREQUENCY RESPONSE .... 125 TO 8000 HZ
SOUND LEVEL RANGE .... 40 TO 100 DB

STAINING SYSTEM - BACTERIOLOGICAL LS924 11111

STAIN AND FIX BIOLOGICAL SPECIMEN. FOR MICROSCOPIC EXAMINATION.

TASKBOARD - FORCE/TORQUE LS925 11131

MEASURE MAN'S CAPABILITY TO APPLY FORCES AND TORQUES IN A VARIETY OF DIRECTIONS FROM VARIOUS HAND/BODY ORIENTATIONS AND RESTRAINT CONDITIONS.

HAND FORCE APPLICATIONS ...... +/- 0.5 POUNDS

RADIATION COUNTER - BIOCHEMICAL SAMPLE LS926 11111

FAST, ACCURATE AND EASY BIOCHEMICAL RADIATION COUNTING SYSTEM BASED ON STANDARD SIZED BIOCHEMICAL SAMPLES.

STANDARD PLANCHET .... UP TO 2 IN DIA
CAPACITY OF PLANCHETS 120

MASS SPECTROMETER LS928 11111

PROVIDE AN ANALYSIS OF AN UNKNOWN IONIZED GAS BY ATOMIC MASS NUMBER

MASS RANGE.....................0 TO 60 AMU

AIR PARTICLE SAMPLE COLLECTOR LS929 11111

AIR PARTICLE AND MICRO-ORGANISM SAMPLES FOR AIR QUALITY DETERMIN-ATION

AIRFLOW .... 1 CU FT/MIN
SAMPLING TIME - CONTINUOUS ... 1 HOUR

AUTOANALYZER - MULTIPLE LS930 11111

AUTOMATIC ANALYSIS OF BLOOD AND APPROXIMATELY 30 OTHER FLUIDS.

SPECTROPHOTOMETER - GENERAL ANALYZER LS931 11111

SPECTRAL ANALYSIS OF GASES AND LIQUIDS INCLUDING SOLIDS OR LIGHT SOURCES.

FREQUENCY .... 250 TO 2500 NANOMETERS
(2500 TO 25000 ANGSTROMS)
ACCURACY .... +/- 0.4 NANOMETERS

ANESTHETIZER - INVERTEBRATES LS932 11114

RENDER INVERTEBRATE ORGANISMS INSENSIBLE TO FACILITATE HANDLING.

ANESTHETIC GAS .... CARBON DIOXIDE

ANTHROPOMETRIC GRID LS933 11111

ANTHROPOMETRIC MEASUREMENTS OF VERTEBRATES EITHER REMOTELY OR AUTOMATICALLY.

SMALL GRID .... 5 X 15 CM SPACED AT 1 MM
MEDIUM GRID .... 50 X 75 CM SPACED AT 2 MM
LARGE GRID .... 2 X 2 M SPACED AT 5 MM

BENCH, LAMINAR AIRFLOW LS934 11114

A GLOVE BOX WITH RELATIVELY HIGH AIR FLOW FOR CONTROL OF PARTICULATE AND GASEOUS CONTAMINANTS WITHIN

BENCH, GENERAL EXPERIMENTS LS935 11134

PROVIDE WORK AREA FOR PREPARATION OF EXPERIMENTS, EXPERIMENT MAINTENANCE OBSERVATIONS, AND PREPARATIONS FOR RETURN TO EARTH

ELECTRICAL UTILITY.............28VDC, 400HZ AC, 60HZ AC
VACUUM UTILITY.................10E-6 TORR
PRESSURE SOURCE................50 PSIG (3.45E4 N/M2)
AVAILABLE GASSES...............OXYGEN, NITROGEN, CARBON DIOXIDE

CAMERA CINE LS936 11111

PROVIDE VISUAL RECORDS SUCH AS PHOTOMICROGRAPHY, TIME LAPSE RECORDS, PHOTOMICROSCOPY AND GENERAL EXPERIMENT DOCUMENTATION

OPERATION MODE.................VARIABLE FRAME RATE OR SINGLE FRAME PULSE OPERATION UNDER REMOTE CONTROL
FILM SIZE......................16 OR 35MM
LEN SELECTION..................″C″ MOUNT LENS SYSTEM; STANDARD ZOOM LENS AS A MINIMUM
EXPOSURE SYSTEM................AUTOMATIC OR ZOOM
FILM CAPACITY.................. 50, 100 OR 200FT (15.2,30.4 OR 60.8M) ROLLS

CAMERA CONTROLLER LS937 11114

DEVICE TO CONTROL THE OPERATION OF VIDEO CAMERAS THROUGHOUT THE LABORATORIES

CAMERA, PLATE FILM LS938 11111

PROVIDE STILL PHOTOGRAPHIC COVERAGE

FILM TYPES.....................HIGH RESOLUTION GLASS PLATE
.....................STANDARD 2 1/4 X 2 1/4 IN (5.75 X 5.75 CM) ROLL
.....................70MM
.....................POLAROID
SHUTTER SPEED..................1 SEC TO 1/500 SEC

VIDEO CAMERA, B/W LS939 401131

PROVIDE MEANS OF ACTIVITY MONITORING, EXPERIMENT DATA ACQUISITION ETC. SYSTEM WILL INTERFACE WITH A 40 INPUT VIDEO MULTIPLEXER TO PERMIT THE MONITORING OF 40 SIMILAR VIDEO CAMERAS.

VISUAL RESPONSE................APPROXIMATE HUMAN EYE

VIDEO OUTPUT....................CONSTANT WITH LIGHT LEVEL
CHANGES OF 10 TO 10000FT CANDLES
1.4V P-P COMPOSITE, CONFORMS TO
EIA RS-170 STANDARD

VIDEO CAMERA, COLOR LS940 11111

PROVIDE COLOR VIDEO OBSERVATIONS OF EXPERIMENTAL ANIMALS, SETUPS, ETC. FOR STORAGE VIA VIDEO-TAPE FOR TRANSMISSION TO THE GROUND.

RESOLUTION (MIN)...............350 LINES
LENS..............................STANDARD 16MM, C MOUNT

CENTRIFUGE,REFRIGERATED,HIGH SPEED LS941 11111

SEPARATION EQUIPMENT TO SUPPORT MEDICAL AND BIOLOGICAL RESEARCH.

OPERATING TEMPERATURE..........35 TO 50F (2 TO 10C)
SPEED..........................0 TO 20000RPM

CENTRIFUGE, MICRO LS942 11111

CENTRIFICAL SEPARATION OF BIOLOGICAL SAMPLES

CAPACITY.........................4 SAMPLES
SPEED(MIN).......................1750RPM
GLASS TUBE SIZES............... 0.5 TO 5 ML

VACUUM CLEANER LS943 11111

COLLECT GENERAL LABORATORY WASTE MATERIALS, DIRT, DUST AND DEBRIS

VACUUM BAG VOLUME...............0.36CU.FT. (10.2LITERS)

CLINOSTAT LS944 11111

MOTOR DRIVEN MOUNTING STRUCTURE TO PROVIDE CONTINUOUS ROTATION OF PLANT SAMPLES

ROTATION RATES..................TBD
PLATFORM LIGHTING...............TBD

COMPACTOR, WASTE SOLIDS LS945 11111

COMPACTS WASTE SOLIDS FOR EASY HANDLING

COMPACTION(MIN).................1/4 INITIAL VOLUME

CONSOLE,BEHAVIORAL MEASUREMENTS LS946 11114

DEVICE THAT MEASURES MENTAL PROCESSES, ATTITUDES, ETC. SUCH AS COGNITIVE PROCESSES, INDIVIDUAL BEHAVIORAL TRAITS, GROUP BEHAVIORAL TRAITS, ETC. CONSOLE INCLUDES GENERAL PURPOSE DISPLAY AND GENERAL PURPOSE RESPONSE KEYBOARD

PROCESSES MEASURED.............COMPLEX PERCEPTUAL
............CONCEPTUAL AND THINKING ABILITY
............MEMORY
............REACTION TIME-SIMPLE AND COMPLEX
............INDIVIDUAL BEHAVIORAL TRAITS
............GROUP BEHAVIORAL TRAITS

DIGITAL COMPUTER LS947 11111

PROVIDE AUTOMATIC DATA ACQUISITION OF EXPERIMENTAL DATA, CONTROL LIGHTING AND ANIMAL FEEDING AND GENERAL LABORATORY ENVIRONMENT MONITORING. THE COMPUTER WILL SUPPORT ANALYTICAL TOOL SUCH AS MASS SPECTROMETERS. GAS ANALYZERS AND DIALYSIS EQUIPMENT. ALSO DRIVES ONE OR MORE CRT INTERACTIVE DISPLAY CONSOLES

MEMORY CAPACITY.................16BIT 16,000 WORD
CYCLE TIME......................1MICROSECOND
PERIPHERAL CAPABILITIES........DIRECT MEMORY ACCESS
.......FLEXIBLE INTERRUPT STRUCTURE
.......SINGLE BIT SET AND SENSE LINE
CAPABILITY OF UP TO 64 LINES
EACH

ANALOG TO DIGITAL CONVERTER LS948 11111

SUPPORT DIGITAL COMPUTER. INCLUDES LO-LEVEL MULTIPLEXER. UNIT SHOULD BE A PROGRAMMABLE GAIN 12 BIT TYPE

DISK STORAGE SYSTEM LS949 11111

STORES DATA IN SUPPORT OF COMPUTER

STORAGE CAPACITY ....5.0E6 WORDS

MAGNETIC TAPE RECORDER LS950 11111

RECORD DATA

DATA RATE ....30K BPS
TOTAL DATA STORED ....16.0E09 BITS

CRT DISPLAY LS951 41111

DISPLAY GRAPHIC AND ALPHANUMERIC DATA

AUTOMATIC COLONY COUNTER LS952 11111

DETERMINE THE NUMBER OF VIABLE COLONIES GROWING ON AN AGAR SUBSTRATE

DEIONIZER, WATER LS953 11111

PROVIDES A MEANS OF REMOVAL OF CATIONS AND ANIONS FROM WATER SUPPLIES REQUIRED FOR SPECIALIZED LABORATORY ANALYSIS

SOLIDS REMOVAL CAPABILITY.....<1 PPM
IONS REMOVAL CAPABILITY.......<1 PPM

ELECTROPHYSIOLOGY DISPLAY LS954 11114

DEDICATED DISPLAY FOR PHYSIOLOGICAL DATA TRANSMITTED BY THE ELECTROPHYSIOLOGY BACKPACK

ELECTROMETER LS955 11111

MEASURE SMALL VOLTAGES AND CURRENTS FOUND IN NERVES AND MUSCLES.

DC VOLTAGES MEASURED...........+/-10MICROVOLTS TO +/-1VOLT
DC VOLTAGES MEASURED...........+/-1 PA TO +/-3 MA
DRIFT..........................+/-5V/DAY AFTER 10MIN WARMUP
OUTPUT.VOLTAGE.................+/-10V

ELECTROPHORESIS APPARATUS LS956 11111

SEPARATES PROTEIN AND AMINO ACID CONSTITUENTS IN SERUM,PLASMA, URINE OR SPINAL FLUID FOR QUANTITATIVE ANALYSIS.

VOLTAGE........................0 TO 500 V DC
SUBSTRATE......................STARCH BLOCK, PAPER OR GEL
SAMPLE VOLUME..................0.001 TO ML

FREEZER, GENERAL LS957 11111

STORAGE OF SERUM, PLASMA, SPECIMENS AND ORGANISMS

OPERATING TEMPERATURE.........-4F (-20C)
TEMPERATURE TOLERANCE.........+/-4F(+/-2C)
STORAGE VOLUME.................4 CU. FT. (0.11CU.M.)

FREEZER, LOW TEMP LS958 11111

STORAGE OF EXPERIMENT SPECIMENS

OPERATING TEMPERATURE.........-94F(-70C)
STORAGE VOLUME.................1 CU.FT. (0.028 CU.M.)

REFRIGERATOR LS959 11111

STORE SERUM AND PLASMA

OPERATING TEMPERATURE.........32 TO 40F(0 TO 4C)
STORAGE VOLUME.................1 CU.FT. (0.028 CU.M)

REFRIGERATOR, RADIO ISOTOPE STORAGE LS960 11114

STORE LIQUID AND SOLID RADIOACTIVE MATERIALS

OPERATING TEMPERATURE.........41+/-4F(5+/-2C)
VOLUME.........................1CU.FT.(0.028CU.M.)
ISOTOPES STORED................H3,C14,FE59,CR51,I131,CO45

GAS ANALYZER, CO2 SPECIFIC LS961 11111

THIS DEVICE IS USED TO MONITOR ATMOSPHERIC CARBON DIOXIDE LEVELS

PARTIAL PRESSURE RANGE........130 - 2700PA(1-20 MM HG)

GAS CHROMATOGRAPH LS962 11111

MEASURES CONCENTRATION OF GAS, LIQUID, AND SOLID CONSTITUENTS OF BIOLOGICAL SAMPLES

OPERATING TEMPERATURE.........-40 TO 752F(-40 TO 400C)
CARRIER GAS....................HELIUM
DETECTORS......................HYDROGEN FLAME
......................THERMAL CONDUCTIVITY
FRACTION COLLECTION SYSTEM

GAS ANALYZER, WATER VAPOR LS963 11111

MONITOR WATER VAPOR CONTENT

MOISTURE RANGE.................0 TO 98% RELATIVE HUMIDITY
(0.001 TO 20000MICROGRAMS/LITER)
TEMPERATURE RANGE.............-166 TO 140F (-110 TO 60C)

KIT, BENCH CHEM ANAL LS965 11111

KIT CONTAINS THE TOOLS AND EQUIPMENT TO MANAGE CHEMICALS AND BIOLOGICALS DURING VARIOUS MANUAL PROCEDURES GENERALLY PERFORMED WITHIN THE GLOVE BOX.

TOOLS..........................SOLID TRANSPORT TOOLS.GRAVITY
INDEPENDENT PIPETTES, VIALS,
BOTTLES, AND TEST TUBES.
CHEMICALS, STOPPERS, FILTERS,
AND SAFETY SHIELDS

KIT, HEMATOLOGY LS966 11111

PROVIDE TOOLS FOR SAMPLING, HANDLING, TRANSFERRING AND ANALYZING BLOOD

ITEMS..........................HEMATOMETER KIT; 10 LAMBDA
DISPOPIPETTES; COVERSLIPS;
SLIDES; WBC AND RBC DILUENT;
CRITOSEAL; HEMOCRIT TUBES(MICRO.
HEPARINIZED); HEMOCRIT TUBES
(MICRO, PLAIN); BLOOD DILUTING
PIPETTES (WBC, RBC); COMBISTIX
(URINE TEST STRIPS); LUER
ADAPTERS, VACUTAINER; VACUTAINER
VACUTAINER-NEEDLE UNIT;
VACUTAINER TUBES, ASSORTED(2"');
SYRINGE (LARGE). PEDIATRIC
ALCOHOL SWABS; LANCETS; NEEDLE,
25GA, 5/8IN; NEEDLE 22GA,1 1/2IN

KIT, LINEAR MEASUREMENT LS967 11111

DETERMINE SIZE, AMPLITUDE, DISTANCE, CIRCUMFERENCE,ETC

ORIGINAL PAGE IS OF POOR QUALITY

Space Division
Rockwell International

ITEMS..............................RULERS; TAPES; LINEAR COMPARATOR; GRIDS; CALIPERS, INSIDE AND OUTSIDE; VERNIER CALIPERS; MICROMETERS, INSIDE AND OUTSIDE

KIT, MICROBIOLOGY LS968 11111

PROVIDE TOOLS TO FACILITATE GROWING AND ANALYZING MICROBIAL ORGANIZING

ITEMS..............................INOCULATING LOOP; INOCULATING NEEDLE; COTTON SWABS, PACKAGES, STERILE; SYRINGE 5ML, STERILE; SLIDES, MICRO; ALCOHOL; TUBES, 15X75MM, STERILE, CAPPED; ZEPHIRAN, TINCTURE, 1:500; BACTECINERATOR(STERILIZING UNIT) ; THIOGLYCOLLATE, TUBED; STUART TRANSPORT MEDIA, VIALS; TSA SLANTS

KIT, ORGANISM HOLDING AND MANAGEMENT LS969 11111

PROVIDE TOOLS AND DEVICES USED IN THE HOLDING AND HANDLING OF THE ORGANISMS

ITEMS FOR SMALL VERTEBRATES......GLOVE POWDER; CAGE SHIELD, PLASTIC; PLASTIC LINER WITH PAD; FOOD PELLET DISPENSER; ALCOHOL SWABS; TOWELS, PAPER, DISPO.; PLASTIC BAG(FOR EXPENDIBLES); PLASTIC BAG(FOR NONEXPENDIBLES); ORGANISM TRANSFER CAPSULE; ANIMAL TAGS

ITEMS FOR PLANTS...............WATERING DEVICE(SPRAY BOTTLE); LABELS; FERTILIZER PACKETS; STAKES(10CM)

KIT, PLANT TOOLS LS970 11111

PROVIDE TOOLS FOR VARIOUS PLANT MANIPULATIONS

ITEMS..............................SCISSORS, TWEEZERS, SPATULA, APPLICATOR, SPLINTS, TAPE DISPENSER, HYPODERMIC NEEDLES, SYRINGES, FORCEPS, PLIERS, SCREWDRIVER, SCALPELS, SEALERS

KIT, GENERAL TOOL LS971 11111

MECHANICAL AND ELECTRICAL TOOLS AND HARDWARE TO PROVIDE CONVENTIONAL DIAGNOSTIC, MAINTENANCE, AND SERVICE FUNCTIONS.

TOOLS..............................HAMMER, WRENCHES, PLIERS, SCREW DRIVERS, DRILL, ADHESIVE TAPE, WIRE CUTTERS, WIRE TIES, WIRE, LUBRICANTS, FLASHLIGHT, SCISSORS , MULTIMETER, FASTENERS, CLAMPS, LAMP

LYOPHILIZER LS972 11111

PROVIDE FREEZE DRYING OF SMALL SPECIMENS

SAMPLE CAPACITY.................20-100CU.IN.(16CC)
TEMPERATURE RANGE..............-40F TO 252F(-40 TO 122C)

MASS MEASUREMENT DEVICE, MACRO LS973 11132

MEASURE MASS OF ITEMS SUCH AS BAGS OF FOOD, BEVERAGE CONTAINERS, CONTAINERS OF URINE AND FECES, LARGE SPECIMENS, ETC

MASS RANGE......................0.22 TO 66LB (0.1 TO 30KG)

MASS MEASUREMENT DEVICE, MICRO LS974 11132

MEASURE SMALL TEST SPECIMENS

MASS MEASUREMENT RANGE.........1MG TO 100 G

OPTISCAN-FIELD AND FIXATION POINT RECORDER LS975 11111

THIS INSTRUMENT PERMITS THE RECORDING OF THE VISUAL FIELD AS THE SUBJECT'S FIXATION WITHIN THE FIELD WITHOUT RESTRICTION OF HEAD MOVEMENTS

ACCURACY.........................2DEG OF ARC

CATALYTIC OXIDIZER SYSTEM LS977 11235

REMOVES UNDESIRABLE COMBUSTION PRODUCTS

OPERATING TEMPERATURE..........700F(370C)
AIR FLOW RATE...................2CFM AT 14.7PSIA AND 70F

BLOOD PRESSURE CUFF SYSTEM LS978 11132

PRESSURE MEASURING TRANSDUCER CUFF USED TO MEASURE BLOOD PRESSURE OF PRIMATES. SYSTEM INCLUDES AIR PUMP FOR AUTOMATED MEASURING, PRESSURE CUP AND TRANSDUCER, AND SIGNAL CONDITIONER.

RADIATION SOURCE STORAGE LS979 11112

STORAGE FACILITY FOR RADIOACTIVE MATERIAL.

VOLUME APPROXIMATELY .... 1 CU FT
RADIATION PROTECTION LIMIT .... UP TO 500 MICROCURIES

RECEIVER - BIOTELEMETRY LS980 11111

RECEPTION OF BIOTELEMETRY SIGNALS FROM DEEP BODY TEMPERATURE AND ANIMAL ACTIVITY AS WELL AS FOR ELECTROMAGNETIC FIELD MONITORING.

FREQUENCY RANGE .... TO 5 MHZ

SENSITIVITY .... 0.5 MV FOR 20 DB QUIETING
TUNING .... VARIABLE AND CRYSTAL CONTROLLED

VISION TESTER LS981 11235

OPTICAL DEVICE (WITH HOOD AND RESPONSE KEYBOARD) THAT MEASURES A VARIETY OF VISUAL FUNCTIONS.

WASTE STORAGE SYSTEM LS982 11111

PROVIDE FOR HANDLING, STORAGE AND DISPOSAL OF SOLID AND LIQUID WASTE MATTER FROM THE EXPERIMENTS.

CAPACITY .... 5 CU FT

STERILIZER - TOOL LS983 11111

STERILIZE MISCELLANEOUS SMALL METAL HAND TOOLS SUCH AS SCALPELS, BY MEANS OF ELECTRICAL INDUCTION HEATING.

CAPACITY .... 0.1 CU FT

AUDIO STERIO HEADSET LS985 11111

EARPHONES FOR VARIOUS MSI HEARING TESTS

FLOW METER, WATER MANIFOLD LS989 11235

IN LINE MEASUREMENT OF WATER FLOW, GENERALLY A LOW RATE ASSOCIATED WITH WATER CONSUMPTION BY ORGANISMS

FLOW METER, GAS LS992 11111

MEASURE AIR FLOW

IMPEDANCE PNEUMOGRAPH LS995 11111

MEASURE BREATHING CYCLE CHARACTERISTICS

KIT, CLEAN UP LS999 11111

GENERAL PURPOSE CLEAN UP - SPONGES AND WIPES

KIT, MEDICAL SURGICAL LS1000 11111

FOR VARIOUS MINOR SURGICAL PROCEDURES

KIT, PHYSIOLOGY LS1001 11111

SPONGES, SPONGE SQUEEZER, VIALS, CALORIC STIMULATOR FOR EAR CANAL, SYRINGES, THERMOMETERS, ETC.

KIT,TOOL - INSECT MANIPULATION LS1002 11111

TOOL KIT FOR COUNTING, SORTING, EXAMINATION,ETC.

MICROPHONE LS1007 11111

MICROPHONES USED FOR BIOLOGY, BIOMEDICINE AND MANNED SYSTEMS INTEGRATION

MICROPHONE AMPLIFIER LS1008 11111

AMPLIFY SIGNALS FROM AMPLIFIER

MONITOR, VIDEO LS1009 11111

MONITOR TV PICTURES OF ANIMAL AND OTHER LAB ACTIVITIES

PUMP GAS, CIRCULATING LS1011 11111

PUMP FOR SEALED PLANT GROWTH CHAMBER

TIMER, EVENT LS1020 11111

GENERAL PURPOSE ELAPSED TIME DEVICE USED FOR VARIOUS PSYCHOMOTOR TESTS

CARDIOGRAPH - IMPEDANCE LS100 11111

BLOOD FLOW RATE FROM HEART.

BLOOD FLOW RATE .... 2 TO 25 LITERS/MIN +/-5 PCT FS

ECG/VCG LS101 31131

MONITOR HEART CONDITION. ELECTRO/VECTORCARDIOGRAPH.

SENSITIVITY .... 0 TO 3 MV +/-1 PCT FS
HEART RATE .... 40 TO 180 BEATS/MIN

EEG - ELECTROENCEPHALOGRAPH LS102 11131

MONITOR ELECTRICAL IMPULSES GENERATED BY THE BRAIN.

SENSITIVITY .... 10 TO 200 MICROVOLTS +/-1 PCTFS
FREQUENCY RESPONSE .... 0.2 TO 100 HZ
CHANNELS 6

DYNAMOMETER LS103 11133

MEASUREMENT OF FORCE OR POWER.

ARM FLEXION .... 25 TO 75 LB (10 TO 35 KG)
BACK EXTENSION .... 100 TO 200 LB (40 TO 80 KG)

EMG - ELECTROMYOGRAM LS104 11131

MONITOR THE MOVEMENT OF THE BODY MUSCULAR SYSTEM.

SENSITIVITY .... 0.01 TO 5 MV +/-1 PCT FS
BANDWIDTHS .... 0.5 TO 200 HZ, 0.5 TO 1000 HZ
CHANNELS 1

PHONOCARDIOGRAM LS106 11111

AURAL MONITOR OF HEART BEAT.

SENSITIVITY .... 0.1 TO 1000 HZ, +/-5 PCT FS

METABOLIC ANALYZER LS1003 11131

MEASURE O2 CONSUMPTION, CO2 PRODUCTION, MAXIMAL O2 CONSUMPTION AND ALVEOLAR PO2 AND PCO2.

O2 VOLUME .... 0 TO 40 L/MIN, +/-3 PCT FS
CO2 VOLUME .... 0 TO 40 L/MIN, +/-3 PCT FS
ALVEOLAR O2 .... 20 TO 120 MM HG +/-2 PCT FS
ALVEOLAR CO2 .... 20 TO 70 MM HG +/-2 PCT FS

PULMONARY FLOWMETER LS990 11131

BLOOD FLOW RATES AND VOLUME.

FLOW RATE .... 0 TO 15 L/MIN, +/-3 PCT FS
VOLUME .... 0 TO 7 L, +/-3 PCT FS

TRANSCUTANEOUS DOPPLER FLOWMETER LS991 11112

MEASURE PULSE WAVE CONTOUR.

ULTRASONIC SIGNAL .... 1 AND 5 MHZ

PULSE WAVE LS112 11112

MEASURE BLOOD VELOCITY

VELOCITY .... 3 TO 15 M/S, +/-0.1 M/S

ERGOMETER - BICYCLE LS586 11131

WORKLOAD MEASURING DEVICE.

LOAD RANGE .... 0 TO 300 WATTS, +/-2 PCT FS
ROTATIONAL SPEED .... 40 TO 90 RPM

LITTER CHAIR - ROTATING LS114 11131

GRAVITY INDUCING DEVICE AND HORIZONTAL WORK TABLE.

ROTATION SPEED .... 0 TO 60 RPM

LBNP - LOWER BODY NEGATIVE PRESSURE LS115 11131

MEASURE INTERNAL BODY PRESSURE DIFFERENTIAL.

PRESSURE DIFFERENTIAL .... 50 MM HG BELOW CABIN AMBIENT

EXERCISER/ERGOMETER - PRIMATE LS175 11133

PRIMATE EXERCISER AND WORKLOAD MEASURING DEVICE.

CALORIMETRY MODULE - PRIMATE LS964 11135

PORTABLE AND COLLAPSABLE UNIT WHICH HOUSES, FEEDS, AND ANALYZES THE PRIMATE SPECIMEN WITHIN.

PO2 .... 160 +/-10 MM HG
PN2 .... 580 +/-20 MM HG
PCO2 .... 6 MM HG OR LESS
PH2O .... 12 +/-3 MM HG
TEMPERATURE .... 77 +/-4 F (25 +/-2 C)

MASS MEASUREMENT DEVICE - BODY LS967 11131

TOTAL BODY MASS DETERMINATION BY OSCILLATING FREQUENCY.

MASS .... 125 TO 230 LB,+/-0.1 PCT FS
(50 TO 100 KG)

LIGHTING SYSTEM - PLANT LS1018 21114

PROVISIONS FOR LIGHT PLANT GROWING AREAS.

TYPE LIGHT .... DAYLIGHT-FLUORESCENT
ILLUMINATION .... 102 FT-C (1100 LUM/M2)

PLANT GROWTH AND SUPPORT CONTAINERS LS1015 121111

VARIOUS SIZE CONTAINER TO ENVIRONMENTLY HOUSE SEEDLINGS.

CAPACI. .... UP TO 20-CM PLANTS

CELLS/TISSUE HOLDING UNIT LS1016 121114

COMBINATION HOLDING UNIT/INCUBATOR CONTAINING ELECTRONIC PLUG-IN CAPABILITY FOR MEASUREMENT DEVICES

TEMPERATURE RANGE .... 41 TO 140 F (5 TO 60 C)
PCO2 .... 160 +/-5 MM
PN2 .... 600 +/-20 MM
PCO2 .... 3 MM OR LESS
TOTAL PRESSURE .... 760 +/-20 MM
RELATIVE HUMIDITY .... 60 TO 100 PCT

CELLS/TISSUE HOLDING UNIT LIGHTING LS1017 21114

PROVISION FOR PROVIDING COOL DIFFUSED LIGHT

ILLUMINATION .... 90 +/-10 FT-C
TEMPERATURE .... AMBIENT

SPACE TECHNOLOGY

CONDENSER STI02 11131

CONDENSATE TANKS STI02 21113
DEVICE TO CONDENSE STEAM IN ZERO GRAVITY

TANKS FOR STORAGE OF CONDENSATE

PRESSURE......................... 20PSI (1.38X10E5 N/M**2)

SUPPORT ELECTRONICS ST006 21114

ELECTRONICS SUPPORT COMMUNICATIONS EXPERIMENTS INCLUDING MULTIPLEXERS WITH CONVERTERS AND OSCILLATORS

OSCILLOSCOPE ST007 21111

MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATING IN THE L-BAND RANGE (390 TO 1550 MHZ).
USED IN ST01S, ST02S, ST03S, ST04S, ST05S, ST06S, ST07S, AND ST09.

BANDWIDTH .... 390 TO 1550 MHZ
CHANNELS 2
DEFLECTION FACTOR .... 10 MV/DIVISION
PHOTOGRAPHIC CAPABILITY .... YES

TAPE RECORDER, DIGITAL ST008 21111

RECORD AND PLAYBACK OF DIGITAL DATA IN SUPPORT OF MICROWAVE INTERFEROMETER AND TRACKING INVESTIGATIONS.
USED IN ST01S, ST02S, ST03S, ST04S, ST05S, ST06S, ST07S AND ST09S.

SIGNAL TYPE .... 0 TO 5 VDC
BANDWITH .... 100 TO 250 KHZ
CHANNELS .... 4 (MINIMUM)
DATA REQUIREMENT .... 2 HRS (MINIMUM)

DATA BUFFER ST010 21111

CAPABILITY TO ACCEPT VERY HIGH DATA RATES, PROVIDE SHORT DURATION STORAGE AND LOWER RATE DUMP CAPABILITY. USED IN ST01S.

WORD LENGTH .... 8 TO 32 BITS
OUTPUT RATE .... VARIABLE AT 0 TO 5 VDC
STORAGE DURATION .... INFINITE

DIGITAL PHASE METER ST011 41111

METER TO DISPLAY PHASE OF SIGNAL RECEIVED BY MICROWAVE INTERFEROMETER

BOOM CONTROLS ST012 11114

CONTROLS FOR MICROWAVE INTERFEROMETER BOOMS

RECORDER - STRIP CHART ST015 11111

RECORD ANALOG MICROWAVE RADIOMETER DATA MONITORING SEA SURFACE TEMPERATURE AND ROUGHNESS.
USED IN ST01S.

FREQUENCY RESPONSE .... 150.0 HZ
SENSITIVITY .... 10 MV/DIVISION
CHANNELS 2
INPUTS 2

SIGNAL GENERATOR ST016 11111

ACCURATELY REPRODUCE IN PULSE FORM THE OUTPUT OF A MICROWAVE RADIOMETER MONITORING SEA SURFACE STATE AND TEMPERATURE.
USED IN ST01S.

REPITION RATE .... CW
OUTPUT VOLTAGE .... +/- 5 VDC

SPECTRUM ANALYZER ST017 11111

SUPPORT SETUP, CHECKOUT AND SIGNAL OUTPUT ANALYSIS OF RF RADIOMETER UNIT AND SWEEP RECEIVER (CRT DISPLAY OF SWEEP RECEIVER AMPLITUDE VERSUS FREQUENCY).
USED IN ST01S AND ST02S.

BANDWIDTH .... 30 TO 10000 MHZ
RESOLUTION .... 2 %
SENSITIVITY .... 10 MV/DIVISION

CAMERA - STILL (VISIBLE) ST020 31111

STILL PHOTOGRAPHIC COVERAGE OF THE EARTH TARGET AREA IN THE VISIBLE REGION (REQUIRES SIMULTANEOUS PHOTOGRAPH IN THE INFRARED RANGE). USED IN ST01S, ST02S AND ST03S.

VIEW ANGLE .... 14.5 DEGREES
RESOLUTION .... 100 LINES/MM
FILM FORMAT .... 5 INCHES
SHUTTER .... 8 TO 1/8000 SEC

DISPLAY TERMINAL ST020 21111

TERMINAL CONSISTING OF ALPHANUMERIC KEYBOARD AND CRT DISPLAY FOR MONITORING EXPERIMENT ACTIVITIES

COMPUTER ST024 21111

COMPUTER CAPABILITY TO PROVIDE BASIC POINTING AND TRACKING INFORMATION RELATIVE TO ATT STABILITY AND FLIGHT PATH REQUIREMENTS.
USED ON ST01S, ST03S, ST04S AND ST05S.

MONITOR - TV ST026 31111

DISPLAY HIGH RESOLUTION TELEVISION PICTURES IN REAL-TIME OR FROM VIDEO TAPE. USED ON ST01S, ST02S, ST03S, ST04S AND ST05S.

RESOLUTION .... 625 LINES
FRAME RATE .... 30 FPS
SCREEN SIZE .... 10 IN (25.4 CM)

DATA PROCESSING EQUIPMENT ST035 11111

HIGH SPEED DIGITAL DATA CONVERSION TO ANALOG FORM COMPATIBLE FOR REAL TIME DISPLAY. USED ON ST01S, ST02S AND ST03S.

CHANNELS 32
DIGITAL-DATA .... 10E+06 BPS

STORAGE - GAS SOURCE ST045 81111

GAS SOURCE STORAGE BOTTLES CAPABLE OF STORING VARIOUS GASES AT HIGH PRESSURES. SIMILAR TO STANDARD K-BOTTLES. USED IN ST01S, ST02S AND ST03S.

VOLUME - PHYSICAL .... 5 CU FT EA (0.16 CU M)
PRESSURE MAXIMUM .... 1000 PSI

GENERATOR - AEROSOL ST046 11135

CAPABILITY TO PRODUCE FINE LIQUID PARTICLES REQUIRED FOR VARIOUS EXPERIMENTS. USED IN ST01S, ST02S AND ST03S.

GENERATOR - ION ST047 11113

IONIZE AEROSOL PARTICLES SO AS TO OBSERVE ZERO GRAVITY MOTION.
USED IN ST01S, ST02S AND ST03S.

VAPORIZER - WATER ST048 21135

CAPABILITY TO PROVIDE COOL WATER VAPOR TO EXPERIMENT CONTAINER.
USED IN ST01S, ST02S AND ST03S.

LIGHT SOURCE ST049 21111

PORTABLE LIGHT SOURCE USED FOR PHOTOGRAPHING EXPERIMENT OPERATIONS AND RESULTS. USED IN ST01S, ST02S AND ST03S.

ILLUMINATION .... 100 TO 1000 LUMENS
DISTANCE .... UP TO 30 FEET

ENVIRONMENT CHAMBER ST050 11135
... OPTICAL CHAMBER TO MONITOR OPTICAL PROPERTIES OF AEROSOLS WITH CAPABILITY TO PERTURBATE THE ENVIRONMENT WITH IONS AND OBSERVING THE AEROSOLS THROUGH A MICROSCOPE AND PHOTOGRAPHING THE SCENE. USED IN ST01S, ST02S AND ST03S.

MICROSCOPE ST051 21111

MICROSCOPIC EXAMINATION OF AEROSOL PARTICLES IN THE VISUAL RANGE. ALSO COMPATIBLE WITH BIOLOGICAL AND METALLURGICAL EXPERIMENTS.
USED ON ST01, ST02S AND ST03S.

MAGNIFICATION RANGE .... 50 TO 1000 X
PHOTOGRAPHIC CAPABILITY .... YES

CAMERA - CINE ST054 61111

PHOTOGRAPHIC RECORD OF THE ACTIVITY OF AEROSOL PARTICLES IN NORMAL, SLOW MOTION AND TIME-LAPSE SEQUENCES
USED IN ST01S, ST01S, ST03S, ST04S, ST05S AND ST06S.

VIEW ANGLE .... 40 DEGREES
RESOLUTION .... 200 LINES/MM
SHUTTER .... 1/50 TO 1/500 SEC
FILM FORMAT .... 16 MM
CAMERA SPEED .... 1, 8, 16, 64 FPS

TAPE RECORDERS (HIGH-SPEED MULTICHANNEL) ST056 11111

MULTIPLE CHANNEL HIGH SPEED ELECTRONIC DATA RECORDING SYSTEM.
USED ON ST01S, ST02S AND ST03S.

BANDWITH .... 1 KHZ TO 2.0 MHZ
CHANNELS 14
SIGNAL TYPE .... ANALOG

SPECTROMETER - GAMMA RAY ST063 11111

MEASURE SPACECRAFT GAMMA RADIATION BY CRYOGENICALLY COOLED LITHIUM DRIFTED GERMANIUM DETECTOR WITH ANTI-COINCIDENCE SHIELD. USED IN ST01S AND ST03S.

ELECTROMAGNETIC ENERGY........ 100 KEV TO 6 MEV

SPECTROMETER - CHARGED PARTICLE ST064 11111

THIRTY MULTI-WIRE PROPORTIONAL COUNTER WITH INTERVENING LAYERS OF TISSUE EQUIVALENT PLASTIC. USED IN ST01S AND ST03S

PROTON ENERGY RANGE .... 5 TO 230 MEV
DEUTERIUM ENERGY RANGE......... 10 TO 300 MEV
TRITIUM ENERGY RANGE........... 15 TO 230 MEV
HELIUM-3 NUCLEI ENERGY RANGE . 20 TO 400 MEV
ALPHA PARTICE ENERGY RANGE ... 25 TO 450 MVE

SPECTROMETER - NEUTRON ST065 11111

LIQUID SCINTILLATOR WITH ANTI-COINCIDENCE SHIELD PULSE SHAPE DISCRIMINATOR. USED ON ST01S AND ST03S.

NEUTRON ENERGY RANGE .... 0.5 TO 15 MEV

DATA CONVERTER - ANALOG TO DIGITAL ST067 21111

CONVERT ANALOG SIGNAL DATA TO DIGITAL DATE FOR RECORDING AND LATER DUMPING TO GROUND STATIONS. USED ON ST01S AND ST03S.

FILM BADGE ST070 121111

MONITOR ASTRONAUT PERSONAL RADIATION DOSE, DOSE RATE AND DOSE HISTORY. USED IN ST015, ST025 AND ST035.

DOSE RATE .... 0 - 0.1 MR/HR
0 - 1000 R/HR

DOSIMETER - THERMOLUMINESCENT ST071 41111

PASSIVE DOSIMETER USING THERMOLUMINESCENCE TO MONITOR RADIATION. USED IN ST015 AND ST025.

ENERGY RANGE DOSE .... 1 TO 10E+05 RADS

REFRIGERATOR ST080 11111

PROVIDE A COLD STORAGE AREA TO HOUSE SPECIMEN. USED IN ST015, ST025 AND ST035.

TEMPERATURE .... 5 C (278 K)
SIZE APPROXIMATELY .... 3 X 2 X 1 FT (76.2X50.7X25.4CM)

COLONY GROWTH ENVIRONMENTAL CHAMBER ST081 11112

HOUSING FOR COLONIES OF BACTERIA WHICH CAN BE OBSERVED DURING EXPERIMENT. USED IN ST015, ST025 AND ST035.

SIZE APPROXIMATELY .... 5 X 5 X 7 IN (13 X 13 X 18 CM)

MICROBIOLOGICAL SAMPLE STORAGE ST082 21112

STORAGE RACK FOR SPACE-TYPE PLASTIC BAG, SWABS AND CAPSULES TO DESTROY BACTERIA IN CASE OF BREAKAGE. USED IN ST015, ST025 AND ST035.

SIZE APPROXIMATELY .... 16X13X6 IN (40X33X15 CM)

INCUBATOR ST083 11111

CONTAINER USED TO PROVIDE VARIABLE TEMPERATURE ENVIRONMENTS FOR BIOSCIENCE SPECIMEN. USED IN ST015, ST025 AND ST035.

SIZE APPROXIMATELY .... 2X1.5X0.5 FT (66X51X15 CM)
TEMPERATURE .... TO 100 F (40 C)

COULTER PRINTER-LOCATER ST084 11111

PROVIDE AUTOMATIC BLOOD ANALYSIS (HEMOGLOBIN, HEMATOCRIT, RED BLOOD CELL COUNT, WHITE BLOOD CELL COUNT, MEAN CELL VOLUME, MEAN CELL HEMOGLOBIN AND IT'S CONCENTRATION). USED IN ST015, ST025 AND ST035.

SPECTROMETER - VOLUMETRIC ST085 11111

PROVIDE A PHOTOGRAPHIC MEANS TO MEASURE INDEPENDENT VOLUME OF CELLS AND CELL SHAPES. USED IN ST015, ST025 AND ST035.

ELECTROPHORESIS APPARATUS ST088 11111

MEASURE ELECTROPHORESIS MOBILITY, SURFACE-ZETA POTENTIAL, AND SURFACE CHARGE DENSITY OF CELL LINES OVER THEIR LIFE CYCLE. USED IN ST015 AND ST025.

CENTRIFUGE ST090 11111

PROVIDE VARIABLE GRAVITY ENVIRONMENTS TO BIOSCIENCE SPECIMEN GENERALLY LIMITED TO TEST-TUBE SIZE CONTAINERS. USED IN ST015, ST025 AND ST035.

GRAVITY LEVEL INDUCED .... UP TO 10 G REQUIRED

PRESSURE TANK ST098 41111

PROVIDE PRESSURE SOURCE FOR WATER FEED SYSTEM TO STEAM GENERATOR EXPERIMENT

OPERATING PRESSURE............ 100 PSI(6.9X10E5 N/M**2)

WATER RESERVOIR WITH HEATER ST099 11113

STORE WATER FOR STEAM GENERATOR EXPERIMENT

OPERATING PRESSURE............ 30PSI(2.07X10E5 N/M**2)

PUMP ST100 11111

PUMP WATER TO STEAM GENERATOR

FLOW RATE...................... 0.1 LB/HR (0.045KG/MIN)

STEAM GENERATOR ST101 11135

DEVISE TO GENERATE STEAM IN ZERO GRAVITY

AIR SAMPLE UNIT ST105 21111

PERIODIC COLLECTION OF AIR SAMPLES FROM THE SHUTTLE AND ATL PROVIDING TYPE, RATE OF CHANGE AND QUALIFICATION OF MICRO-ORGANISMS AND NON-VIABLE PARTICLES. USED ON ST015 AND ST035.

TIMER ST107 11111

TIMING AND VARIABLE PROGRAMMING CAPABILITY TO OPERATE AND CONTROL EXPERIMENT AND SUPPORTING EQUIPMENT. USED IN ST015 AND ST035.

WORK BENCH ST182 32114

PROVIDE A WORK AREA UPON WHICH EXPERIMENTS AND MAINTENANCE MAY BE PERFORMED. ENCLOSED STORAGE TO BE INCORPORATED IN BENCH. USED ON ST015, ST025, ST035, ST045 AND ST065.

SIZE APPROXIMATELY .... 2X3X4 FT (0.61X0.91X1.2 M)

TAPE RECORDER, ANALOG ST065 1111[illegible]

RECORD VOICE, FM AND VIDEO DATA OF LANDMARK AND STAR TRACKING FIELDS. USED IN [illegible], [illegible] AND [illegible].

BANDWIDTH .... TO 2.5 MHZ
RECORDING FORMAT .... VOICE, FM AND VIDEO
CHANNELS 7

LASER ST116 11111

MODE-LOCKED LASER RANGING SYSTEM MEASURING RANGE, LINE-OF-SIGHT ANGLES, AND RANGE RATE BETWEEN ATL/SHUTTLE AND SEPARATE SPACE VEHICLES INCLUDING RANGE OF ATL TO GROUND.

RANGE TOLERANCE .... +/- 1.18 IN (+/-3 CM) ATL-GND
COOPERATIVE TARGET DISTANCE .. 300 NM (556 KM)

RECEIVER - RF ST127 11111

MEASURE ELECTROMAGNETIC INTERFERENCE AT ORBITAL ALTITUDES IN THE FREQUENCY SPECTRUM OF 400 MHZ TO 15 GHZ. USED ON ST025 AND ST035.

OVERALL SPECTRUM .... 400 MHZ TO 15 GHZ
SPECIFIC MULTIPATH MEASURE.... 1.5 TO 1.6 GHZ
2.025 TO 2.3 GHZ
13.4 TO 15.35 GHZ

TELESCOPE - POINTING ST152 11[illegible]

POINTING TELESCOPE WHICH ALLOWS EXPERIMENT PHENOMENA TO BE OBSERVED AND TRACKED IN SPACE

POWER SUPPLY ST171 21[illegible]

ELECTRICAL POWER REGULATION AND DISTRIBUTION AS REQUIRED AND AT VARIABLE VOLTAGE RANGES. USED IN ST025, ST035 AND ST045.

VOLTAGE .... 0 TO 24 VDC
POWER .... 200 WATTS
SENSITIVITY .... 0.05 VOLT

RECORDER, OPTICAL ST223 11235

RECORD AND PLAYBACK DIGITALLY GENERATED DATA FROM A LASER SYSTEM. USED ON ST025 AND ST035.

BANDWIDTH .... TO 50 MHZ
SIGNAL .... DIGITAL
CHANNELS 3

FREQUENCY METER ST156 11111

MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD, AVERAGE RATIO AND MULTIPLE RATIO OF VHF FREQUENCY SOURCES. USED ON ST035.

BANDWIDTH .... 10 TO 100 MHZ
SENSITIVITY .... +/- 2 %

CAMERA, TV ST025 11131

REAL-TIME VIEWING OF TARGET AREAS, LAND MARK AND STAR FIELD TRACKING, AND SENSOR BORESIGHTING.
USED ON ST045, ST055 AND ST065.

VIEW ANGLE .... 8 TO 10 DEGREES
RESOLUTION .... 1025 LINES

MASS SPECTROMETER ST163 11111

ANALYSIS OF GASEOUS COMBUSTION PRODUCTS FORMED IN ZERO GRAVITY VIA MASS SPECTROSCOPY. USED IN ST045 AND ST065.

MASS RANGE .... 1 TO 1000 AMU
SCANNING RATE .... 60 MSEC TO 600 SEC
SENSITIVITY .... 1 %

GAS CHROMATOGRAPH ST175 21111

ANALYSIS OF COMBUSTION PRODUCTS FOR FLAME CHEMISTRY EXPERIMENTS. USED IN ST045 AND ST065.

PYROMETER ST176 11111

MEASURE TEMPERATURE OF COMBUSTION PROCESS IN FLAME CHEMISTRY EXPERIMENTS. USED IN ST045 AND ST065

TEMPERATURE RANGE .... 0 TO 4000 DEG F

COMBUSTION CHAMBER ST178 11135

CHAMBER WHERE FUELS AND OXIDIZERS ARE INJECTED, ALLOWED TO BURN AND THE FLAME CAPABLE OF BEING MONITORED.

SIZE APPROXIMATELY .... 1.67 DIA X 3.5 FT
(0.51 DIA X 1.0 M)

TANKS - FUEL/OXIDIZER ST179 41135

STIRLOR TYPE TANKS CAPABLE OF STORING CORROSIVE FUELS AND OXIDIZERS IN THE SORTIE LABORATORY AT LOW PRESSURES. USED IN ST045 AND ST065.

SIZE APPROXIMATELY .... 0.75 DIA X 3 FT
(0.225 DIA X 0.9 M)

CHAMBER, CUBICAL TEST ST188 11135

CHAMBER FOR PERFORMANCE OF SUPERFLUID HELIUM AND LIQUID DROP/PARTICLE EXPERIMENTS

DIMENSIONS.......................1.8FT(0.55M)CUBE

Space Division
Rockwell International

ACOUSTIC SPEAKER ST185 61111

PARTICLE POSITIONING DRIVER

FREQUENCY RANGE................ 50 TO 10KHZ

MAGNET, SUPERCONDUCTING ST190 11112

MAGNET FOR DROP/PARTICLE POSITIONING

MOTOR,ELECTRIC ST191 11111

MOTOR FOR CHAMBER DRIVE SYSTEM

CRYOSTAT - HELIUM ST192 11111

DEWAR TYPE STORAGE CONTAINER TO STORE AND DISPENSE LIQUID HELIUM.

SIZE APPROXIMATELY .... 1.5 DIA X 1.7 FT
(0.5 DIA X 0.05 M)

PRESSURE MONITOR ST193 11114

MEASURES PRESSURE IN TEST CHAMBER AND DISPLAYS DIGITALLY

TEMPERATURE MONITOR ST194 11114

MONITORS AND CONTROLS TEST CHAMBER TEMPERATURE

COMBUSTION CHAMBER ST202 11135

CHAMBER TO EXAMINE COMBUSTION IN ZERO GRAVITY

DIMENSIONS..................... 1.67FT(0.48M)DIA.X4.0FT(1.22M)

ELECTRON SPIN RESONANCE/MASS SPECTROMETER ST258 11112

IDENTIFY CONSTITUENTS OF COMBUSTION PRODUCTS

TEMPERATURE SENSORS ST260 11111

SENSOR TO MEASURE TEMPERATURE OF COMBUSTION PROCESS

TEMPERATURE RANGE(EST)....... 1000 TO 3000F

PRESSURE SENSORS ST260 11111

SENSORS TO MEASURE PRESSURE OF COMBUSTION EXPERIMENT

PRESSURE RANGE................. TBD

FUEL TANK ST261 11135

STORE FUEL FOR COMBUSTION EXPERIMENT

VOLUME......................... 2 CU.FT. (0.055 CU.M.)

OXIDIZER TANK ST262 11135

STORE OXIDIZER FOR COMBUSTION REACTION

VOLUME......................... 2 CU.FT. (0.55 CU.M.)

INERT GAS SUPPLY ST263 11111

SUPPLY PRESSURE FOR EXPULSION OF FUEL AND OXIDIZER FROM STORAGE TANKS

VOLUME .... 0.22 CU.FT.(0.006 CU.M)

STROBE LAMP ST197 11111

VARIABLE DISCHARGING STROBE LIGHTS WHICH ALLOW THE STOPPING OF MOTION.

STROBE DISCHARGE RATE .... 1 TO 1000 FLASHES/SEC

CRITICAL STATE TEST CELL ST207 11235

TEST CELL TO TEST CRITICAL POINT PHENOMENA. TEST CELL INCLUDES A THERMAL SHIELD, HEAT EXCHANGER, MICROMETER, CHAMBER, SUPPORT ELECTRONICS AND PRESSURE TRANSDUCERS

ACOUSTIC MEASUREMENT DEVICE ST214 11114

DEVICE CONSISTS OF AN ACOUSTIC CAVITY, AN OSCILLATOR AND A DIGITAL DISPLAY

POOL BOILING TEST CHAMBER ST218 21235

CHAMBER TO EVALUATE POOL BOILING PHENOMENA IN ZERO GRAVITY

INSTRUMENTATION SENSOR SYSTEM ST223 11114

SYSTEM INCLUDE TEMPERATURE, PRESSURE AND ACCELEROMETER SENSORS

CRYSTALIZER SAMPLE CHAMBER ST225 11135

CHAMBER FOR GROWING CRYSTALS IN ZERO G

SCHLIEREN TYPE OPTICS SYSTEM ST227 11135

OPTICS SYSTEM EMPLOYING SCHLIEREN METHOD TO EXAMINE THE STRUCTURE OF CRYSTALS

HOLOGRAPHIC INTERFEROMETER ST231 11235

DEVICE TO EXAMINE STRUCTURE OF GROWING CRYSTALS

ACCELEROMETER,TRIAXIAX ST235 21111

ORIGINAL PAGE IS
OF POOR QUALITY

COMMUNICATIONS AND NAVIGATION

TRACKING ANTENNA SERVO ELECTRONICS CN044 11114

ELECTRONICS FOR ANTENNA POSITIONING AND CONTROL

TYPE	TYPE II SERVO LOOP
GAIN CONSTANT	3.5E4 PER SEC SQUARED
BANDWIDTH	100 HZ

RECEIVER, L BAND CN045 21111

RECEIVE L BAND SIGNALS TO DEMONSTRATE THE OPERATIONAL PERFORMANCE OF TYPICAL SPACEBORNE INTERFEROMETERS FOR AIRCRAFT AND MARINE NAVIGATION/TRAFFIC CONTROL. TRACK SIGNAL PHASE.

CARRIER FREQUENCY	1565.75 TO 1570.25 MHZ
SENSITIVITY	-120 DBM
RECEIVER TYPE	PHASE LOCK, SUPERHETERODYNE, FIXED FREQUENCY, AGC
DYNAMIC RANGE	40 DB INSTANTANEOUS 100 DB TOTAL
PRE-DETECTION BW	5 MHZ
SWEEP RATE	TUNE 3 PPM OF CARRIER FREQ
PHASE LOCK LOOP SNR	40 DB
RECEIVER NOISE FIGURE	5 DB
PHASE LOCK LOOP BANDWIDTH	10 HZ

RECEIVER, VHF CN046 51111

RECEIVE VHF SIGNALS FOR DETAILED EVALUATION OF PERFORMANCE CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK. PROVIDES NUMBER OF RECEIVER FRONT ENDS WHICH CAN BE CONNECTED IN DIFFERENT RECEIVE CONFIGURATIONS.

CARRIER FREQUENCY	126 TO 130 MHZ
SENSITIVITY	+/- 25 MHZ
CARRIER/NOISE DENSITY RATIO	53 DBW
DATA RATE	100 TO 1000 BPS

RECEIVER, KU-BAND CN047 11235

RECEIVE KU BAND SIGNAL FOR DETAILED EVALUATION OF PERFORMANCE CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.

CARRIER FREQUENCY	13.4 TO 14.2 GHZ
SENSITIVITY	+/- 25 MHZ
CARRIER/NOISE DENSITY RATIO	96 DB/HZ
DATA RATE	100 TO 1000 BPS DATA UP TO VIDEO

RECEIVER, S-BAND CN048 11111

RECEIVE S BAND SIGNAL FOR DETAILED EVALUATION OF PERFORMANCE CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.

CARRIER FREQUENCY	2025 TO 2120 MHZ
SENSITIVITY	+/- 25 MHZ
CARRIER/NOISE DENSITY RATIO	85 DB/HZ
DATA RATE	100 TO 1000 BPS VOICE

RECEIVER, LASER ELECTRONICS CN049 11235

PERFORMS DATA DEFORMATTING FROM LASER CARRIER BEAM

TRANSMITTER, VHF CN050 11111

PROVIDES MEDIUM POWER OUTPUT FOR TRANSMISSION TO TDRS FOR EVALUATION OF PERFORMANCE CHARACTERISTICS.

CARRIER FREQUENCY	136 TO 144 MHZ
STABILITY	+/- 20 KHZ
OUTPUT POWER	10 WATTS MAX
DATA RATE	100 TO 10,000 BPS
SIGNAL BANDWIDTH	0.1 MHZ
DUTY CYCLE	CONTINUOUS

TRANSMITTER, KU BAND CN051 11235

PROVIDE KU BAND SIGNAL FOR EVALUATION OF PERFORMANCE CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.

CARRIER FREQUENCY	14.4 TO 15.35 GHZ
STABILITY	+/- 25 MHZ
TRANSMITTER POWER	100 WATTS
EFFECTIVE RADIATED POWER	33 DBW
DATA RATE	1.0 MBS VIDEO
DUTY CYCLE	CONTINUOUS
SIGNAL BANDWIDTH	500 MHZ

LASER ASSEMBLY - CO2 CN052 11111

PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH CONTROL, MODULATOR, AND COOLING SYSTEM.

LASER CAVITY	
WAVELENGTH	10.6 MICRONS
LASING MODE	FUNDAMENTAL (TEM..)
OPTICAL OUTPUT POWER	5 WATTS AVERAGE
EFFICIENCY	5 PERCENT
MODULATOR	
TYPE	DIGITAL
DATA RATE	200 MBPS
EXTINCTION RATIO	20 DB
COOLING SYSTEM	
COOLING METHOD	CONDUCTIVE, NO LIQUIDS ALLOWED
HEAD LOAD	200 WATTS

LASER ASSEMBLY - ND:YAG CN053 11111

PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH CONTROL, MODULATOR, AND COOLING SYSTEM.

LASER CAVITY	
WAVELENGTH	1.06 MICRONS
LASING MODE	FUNDAMENTAL (TEM..)
OPTICAL OUTPUT POWER	1 WATT AVERAGE
EFFICIENCY	1 PERCENT
MODULATOR	
TYPE	DIGITAL
DATA RATE	1 GBPS
EXTINCTION RATIO	20DB
COOLING SYSTEM	
COOLING METHOD	CONDUCTIVE, NO LIQUIDS ALLOWED
HEAD LOAD	200 WATTS

LASER LINK, DOUBLED ND:YAG CN054 11111

PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH CONTROL, MODULATOR, DOUBLER, AND COOLING SYSTEM.

LASER CAVITY	
WAVELENGTH	0.53 MICRONS
LASING MODE	FUNDAMENTAL (TEM..)
OPTICAL OUTPUT POWER	0.1 WATTS AVERAGE
EFFICIENCY	0.1 PERCENT
MODULATOR	
TYPE	DIGITAL
DATA RATE	1 GBPS
EXTINCTION RATIO	20 DB
COOLING SYSTEM	
COOLING METHOD	CONDUCTIVE, NO LIQUIDS ALLOWED
HEAD LOAD	200 WATTS

LASER BEACON , ND:YAG CN055 11111

SERVE AS A LIGHT SOURCE TO FACILITATE ACQUISITION AND/OR TRACKING FROM A DISTANT COMMUNICATION TERMINAL.

BEACON TYPE	Q-SWITCHED DOUBLED, MULTIMODE CAVITY.
WAVELENGTH	0.53 MICRONS (PREFERRED)
REP RATE	5 PPS
ENERGY/PULSE	20 MJ AT 0.53 MICRONS
PULSEWIDTH	20 NSEC
PUMP METHOD	FLASH PUMP
CODING TECHNIQUE	PULSE POSITION MODULATION
BEAMWIDTH	VARIABLE 1 DEG TO 1 ARC MINUTE
LIFETIME	10 MEG FLASHES OR GREATER
POWER CONSUMPTION	100 WATTS

FREQUENCY SYNTHESIZER AND DRIVER CN056 11111

RECEIVER FIRST LOCAL OSCILLATOR.

FREQUENCY	60 TO 500 MHZ
STABILITY	+/- 5E-11 PER DEG C
OUTPUT VOLTAGE	1 V RMS +/- 1.5 DB

NOISE FIGURE TEST SET CN057 11111

MEASURE SYSTEM NOISE FIGURE.

NOISE FIGURE RANGE	10 TO 16 DB
ACCURACY	+/- 0.5 DB, 0 - 30 DB
INPUT FREQUENCY	100 TO 1000 MHZ
BANDWIDTH	1 MHZ

SCOPE CAMERA CN058 21111

OBTAIN FILM RECORD OF DATA AND DISPLAYS.

REDUCTION RATIO	1:1, 1:0.7
LENS	F/1.9 TO F/16
SHUTTER	B TO 5 SECONDS
FILM TYPE	POLAROID

FREQUENCY COUNTER CN059 11111

MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE, TIME INTERVAL AND RATIO OF FREQUENCY SOURCES.

BANDWIDTH	1 HZ TO 10 MHZ
SENSITIVITY	[illegible] RMS
TIME BASE	INTERNATIONAL SECOND

RF POWER METER CN060 11111

MEASURE RF POWER OF VARIOUS RF SOURCES.

FREQUENCY RANGES	126 TO 130 MHZ 136 TO 144 MHZ 2025 TO 2120 MHZ 13.4 TO 14.2 GHZ 14.4 TO 15.35 GHZ
ACCURACY	0.02 DB/10 DB

AC/DC VOLTMETER CN061 21111

MEASURE THE VOLTAGE LEVEL OF VARIOUS SIGNAL SOURCES.

VOLTAGE RANGE	+/- 100 MV; 1, 10, 100, 1000 V
FREQUENCY RANGE	45 HZ TO 1 MHZ
ACCURACY	+/- 0.01 % OVERALL

A/D CONVERTER CN062 21111

CONVERT INPUT SIGNAL FROM ANALOG TO DIGITAL FORMAT FOR I/O [illegible]

CAMERA, CINE CN063 11111

PROVIDE PHOTOGRAPHIC RECORD OF TELESCOPE FIELD-OF-VIEW.

- FILM FORMAT .... 35 MM
- OPERATION .... REMOTE
- FRAME RATE .... 16 FPS
- FILM TYPE .... COLOR
- RESOLUTION .... 50 LINES/MM
- LENS .... 100 MM
- FIELD OF VIEW .... 40 DEGREES

OPTICAL ANTENNA SERVO ELECTRONICS CN066 11114

SUPPORT ELECTRONICS FOR OPTICAL ANTENNA

SWEPTBAND RECEIVER AND DEMODULATOR CN067 41111

RECEIVE SIGNALS FROM TERRESTRIAL NOISE AND TERRESTRIAL INTERFERENCE SOURCES AS A FUNCTION OF TIME OF DAY AND SEASON OF YEAR.

- FREQUENCY RANGE .... 100 TO 1000 MHZ SWEEP MODE OR TUNABLE
- RECEIVER TYPE .... SUPERHETERODYNE, LINEAR, SWEPT FREQUENCY, AGC
- SENSITIVITY .... -120 DBM
- PRE-DETECTION BW .... ADJUSTABLE
- DYNAMIC RANGE .... 60 DB INSTANTANEOUS
120 DB TOTAL
- SWEEP RATE .... TWO RECEIVER BW PER MINUTE
- RECEIVER NOISE FACTOR .... 4.0 DB
- BANDWIDTH .... 1 KHZ

ATTENUATOR CALIBRATOR CN068 41111

DYNAMIC RANGE ADJUSTMENT. REMOTE ELECTRICAL CONTROL, DIGITAL READ OUT OF VALUE, MANUAL OVER-RIDE.

- IMPEDANCE .... 50 OHMS
- FREQUENCY .... DC TO 1.5 MHZ
- RANGE .... 0 TO 60 DB

SCAN PROGRAM GENERATOR CN069 31111

GENERATES DIGITAL CONTROL SIGNALS TO CONTROL RECEIVER SWEEP. SUPPLIES DIGITAL READOUT OF FREQUENCY AND LEVEL.

- BANDS 24
- SCAN TIME .... 0.03 TO 300 SECONDS
- CAPABILITY .... ANALOG DATA COLLECT & DISPLAY

SIGNAL FORMATTER CN070 21111

PROVIDES DATA FORMATTING. ACCUMULATES PRE/POST AMBLE. CLOCKS START OF EACH TEST AND DATA ACQUISITION.

- DATA FORMAT .... 8, 16, 32, BITS/WORD
- DATA RATE .... 125000 WORDS PER SECOND

RF VARIABLE POWER SUPPLY CN071 21111

PROVIDES SOURCE OF VARIABLE POWER.

- OUTPUT .... 100 V PEAK
- VOLTAGE GAIN .... 20 X
- DISTORTION .... 0.1 % THD
- FREQUENCY RANGE .... DC TO 30 KHZ

POWER CALIBRATION UNIT CN072 21111

PROVIDES KNOWN INCREMENTALLY CONTROLLABLE POWER LEVEL FOR STANDARDIZATION.

- OUTPUT .... -100 TO +100 V
- LOAD REGULATION .... 1 MV + 0.01 %
- LINE REGULATION .... 10 MV + 0.01 %

TRACKER ELECTRONICS - FINE CN073 21114

PROVIDES ACCURATE TRACKING OF AN OPTICAL BEACON. PROVIDES CONTROL SIGNALS TO THE TELESCOPE GIMBALS AND VERNIER BEAM DEFLECTOR.

- TYPE .... IMAGE DISSECTOR TRACKER
- FOV .... +/- 300 MICRORAD
- ACCURACY .... 0.5 MICRORAD
- SENSITIVITY .... TO 1.06 MICRONS OR 10.6 MICRONS

BIT ERROR COUNTER CN074 11111

COUNT ERROR PULSES OUTPUTED BY THE BIT ERROR DETECTOR TO DETERMINE THE BIT ERROR RATE OF THE DIGITAL TRANSMISSION SYSTEM.

SWITCH/DIPLEX/PREAMP UNIT CN077 11134

FOR SWITCHING ANTENNAS FOR DIFFERENT ALTITUDES, USE OFF RFI CANCELLATION, FORMING OMNI PATTERN ETC

MODEM CN078 11114

MODULATE AND DEMODULATE VOICE OR DATA TRANSMISSIONS WITH OR WITHOUT SPREAD SPECTRUM CAPABILITY. PROVIDES BASELINE COMMUNICATION SYSTEM, ANALOG OR DIGITAL VOICE, AND DIGITAL DATA.

- DATA .... 75 BS TO 50 KBS (VARIABLE)
MOVEABLE SS
- BANDWIDTH .... 2 MHZ

DEMODULATOR CN079 3111

DEMODULATE VOICE OR DATA TRANSMISSIONS WITH OR WITHOUT SPREAD SPECTRUM CAPABILITY. PROVIDES A NUMBER OF RECEIVERS CONNECTED TO DIFFERENT ANTENNAS.

MODEM, WIDEBAND CN080 21235

MODULATE AND DEMODULATE WIDEBAND FM OR DIGITAL SIGNALS. WIDEBAND FM DETECTOR WITH THRESHOLD EXTENSION. DIGITAL DEMOD WITH BIT, SYNCH, AND ERROR CORRECTION CODING. MODULATOR PORTION HAS COMPLIMENTARY CHARACTERISTICS.

D/A AND A/D CONVERTER CN081 11111

PROVIDES FOR A/D AND D/A CONVERSION.

- A/D CONVERTER
  - SAMPLING RATES .... 15 MEGASAMPLES/SEC
  - DATA RATES .... 105 MBS
- D/A CONVERTER
  - BANDWIDTH .... 6 MHZ

CONTROL UNIT - ANTENNA SCAN CN082 11114

PROVIDES VARIABLE ANGULAR SWEEP PATTERNS (SPIRAL RECTANGULAR SCANS, ETC.) OF VARIABLE ANGULAR COVERAGE.

DATA BIT STREAM GENERATOR CN083 11111

PROVIDES TEST BIT STREAMS FOR TRANSMISSION.

- DATA RATES .... 1 TO 105 MBS

COARSE TRACKER CN084 11114

PROVIDES INITIAL GROUND BEACON ACQUISITION AND COARSE TRACKING.

- DYNAMIC (SEARCH) FOV .... 1 DEG BY 1 DEG
- ACCURACY (1 SIGMA) .... +/- 200 MICRORAD
- TRACKING BANDWIDTH .... 1 HZ
- SEARCH TIME .... 10 SEC MAX
- SENSITIVITY .... TO .53 MICRONS
- FALSE TARGET REJECTION .... MUST REJECT MOON, PLANETS, STARS, AND SUNLIT CLOUDS.

LASER TRANSMITTER ELECTRONICS CN085 11235

DATA FORMATTING FOR TRANSMISSION VIA LASER CARRIER

OPTICAL COLLIMATOR CN086 11111

PROVIDES FOR OPTICAL ALIGNMENT OF THE LASER AND TELESCOPE. ALIGNMENT CHECKS TO BE BOTH CONTINUOUS AND PULSED.

LASER POWER SUPPLY CN087 21111

CONVERTS AND REGULATES RAW SPACECRAFT POWER IN A FASHION SUITABLE FOR PUMPING A LASER. PRIME LASER POWER CONDITIONER AND DISTRIBUTION FOR ALL LASERS.

- VOLTAGE OUTPUT ....
- REGULATION .... +/- 0.1 %
- POWER .... 100 WATTS MAX
- TRANSIENT RECOVERY .... 0.1 SECONDS

BEAM EXPANDER OPTICS CN088 21111

PROVIDES VARIABLE BEAM DIVERGENCE CONTROL FOR LASER TRANSMITTER AND THE OPTICAL BEACON TO FACILITATE ACQUISITION.

- TYPE .... AFOCAL WITH VARIABLE ELEMENT SEPARATION.
- INPUT BEAM SIZE .... 0.25 INCH DIA
- EXIT BEAM SIZE .... 1 INCH DIA
- INPUT BEAM CHARACTERISTICS
  - LASER TRANSMITTER .... TEM WAVE, GAUSSIAN DIST
  - OPTICAL BEACON .... 3 MRAD DIVERGENCE, GAUSSIAN DIST
- OUTPUT BEAM DIVERGENCE
  - CO2 LASER TRANSMITTER ...... DIFF LIMIT TO 200 ARC-SEC
  - ND:YAG LASER TRANSMITTER .. DIFF LIMIT TO 50 ARC-SEC
  - OPTICAL BEACON .... 2 ARC-MIN TO 1 DEGREE
- ADJUSTMENT RESPONSE TIME .... 0.5 SEC MAX

BEAM DEFLECTOR CN089 41111

ONE TYPE PROVIDES A VERNIER POINTING CONTROL WITH FASTER RESPONSE AND GREATER PRECISION THAN THE MAIN OPTICS GIMBALS. THE OTHER TYPE PROVIDES A SMALL OFFSET POINTING CAPABILITY BETWEEN THE TRACKER AXIS AND THE TRANSMITTER AXIS.

- DEFLECTION CAPABILITY .... TWO AXIS
- DEFLECTION RANGE .... +/- 200 MICRORAD
- PRECISION .... +/- 0.2 MICRORAD
- SPECTRAL RANGE .... ACCOMODATE LASER TRANSMITTER, RECEIVER AND BEACON.

LASER POWER METER CN090 11111

MEASURE OUTPUT LASER POWER.

- WAVELENGTH .... 0.53, 1.06 AND 10.6 MICRONS
- ACCURACY .... +/- 5 PERCENT
- RANGE .... 300 KW

CALIBRATION SIGNAL GENERATOR CN091 11111

CALIBRATES RECEIVER SENSITIVITY AND PHASE METER.

- FREQUENCY RANGE .... 1565.75 TO 1570.25 MHZ
- FREQUENCY ACCURACY .... +/- 5 MHZ
- FREQUENCY STABILITY .... 0.005 %/DEGREE C
- RF OUTPUT POWER .... +10 DB TO -127 DB

OPEN R.F. AMPLIFIER T.W.T CN092 51111

RECEIVER - NAVAGATION CN096 11111

RECEIVE SIGNALS FROM DIRECT OPTICAL SENSING OF STARS TO INVESTIGATE THE PRECISION WITH WHICH A SATELLITE CAN BE POINTED VERTIC-

ALLY USING STARS AS THE SOLE INERTIAL REFERENCE.

CARRIER FREQUENCY .... 400 MHZ
SENSITIVITY .... 2.0 MV FOR 10 DB S+N/N
DATA RATE .... 2000 BPS

SPECTRUM ANALYZER/OSCILLOSCOPE CA900 21111

SINGLE DESIGN FUNCTIONS AS POWER SPECTRAL DENSITY AND WAVEFORM DISPLAY FOR QUICKLOOK AND AS MODULATION MONITOR.

BANDWIDTH .... 18 GHZ
SENSITIVITY .... 2 MV/DIVISION
CHANNELS......................... 2
PHOTOGRAPHIC CAPABILITY .... YES

COMPUTER, GENERAL PURPOSE CA901 21111

COMPUTER CAPABILITY TO COMMAND EXPERIMENTS ON AND OFF, PROGRAM EXECUTION OF EXPERIMENT PROCEDURAL STEPS, COMPUTE GIMBAL ANGLES FOR TELESCOPE AND ANTENNA POINTING, AND COMPUTATION OF POINT-AHEAD ANGLES.

TIMER, PRECISION CLOCK CA902 11111

PROVIDES PRECISE TIME REFERENCE. MEASURE TIME AT WHICH PHASE MEAS OCCURS.

DISPLAY .... 24 BIT DIGITAL CLOCK WITH 1 HR. TIME PERIOD
DISPLAY TYPE .... DIGITAL
ACCURACY 1E-06

TELEPRINTER CA903 11111

PROVIDES CAPABILITY TO SEND OR RECEIVE TELETYPE MESSAGES.

CHARACTER RATE .... 30 CHARACTERS/SEC (150 BPS)
CONSISTS OF .... SOLID STATE KEYBOARD
SOLID STATE THERMAL PRINTER
EXPANDABLE MESSAGE MEMORY

PHASE METER, DIGITAL CA904 11111

MEASURES RELATIVE PHASE ANGLES OF RECEIVED SIGNALS FOR INTERFEROMETER NAVIGATION/SURVEILLANCE EXPERIMENT.

OUTPUT .... GENERATES 13 BIT PHASE MEAS BASED ON TWO 60 MHZ SINUSOIDS AT 10 DEG.
FREQUENCY RANGE .... 400 MHZ
RESOLUTION .... 25 KHZ
ACCURACY .... +/- 2.5 KHZ

RECORDER, DIGITAL CA905 11111

ACCURATE RECORDING OF RAW DIGITAL DATA

SIGNAL TYPE .... 0 TO 5 VDC DIGITAL
CHANNELS 9
TAPE SPEED .... VARIABLE
DATA RATE .... 1.5E+06BPS

POWER DIVIDER, WIDEBAND CA906 41111

DIVIDES ANTENNA POWER OUTPUT.

INPUT PORTS .... ONE 50 OHM PORT
OUTPUT PORTS .... THREE 50 OHM PORTS

X-Y PLOTTER CA907 11111

PROVIDES REAL-TIME ACCURATE REPRODUCTION OF SPECTRAL DATA SOURCES PLOTTED ON CARTESIAN COORDINATES.

CHANNELS .... 4 PLUG INS
ACCELERATION .... 1500 IN/S/S (3800 CM/S/S)
SENSITIVITY .... 0.5MV/IN (0.25 MV/CM)

KEYBOARD, COMPUTER CA908 11111

PROVIDES FOR CREWMAN TO COMMUNICATE WITH ONBOARD COMPUTER FOR EXPERIMENT CONTROL AND DATA ANALYSIS.

KEYBOARD .... TYPEWRITER TYPE

CAMERA, TELEVISION CA909 11131

PROVIDES ASTRONAUT WITH VIEW OF EARTH SCENE.

VIEW ANGLE .... 20 DEGREES
RESOLUTION .... 625 LINES
SPECTRAL BANDWIDTH .... 4 MHZ
SWEEP RATE .... 15 FRAMES PER SECOND

RECORDER, VIDEO CA910 11111

PROVIDES FOR RECORDING VIDEO DATA.

CHANNELS 2
BANDWIDTH .... 4 MHZ MINIMUM
DURATION .... 1.5 HRS MINIMUM

RECEIVER, PHASE-LOCK CA911 11111

PROVIDES FOR TRACKING SIGNAL PHASE.

FREQUENCY SPECTRUM .... 1570 MHZ TUNABLE
SENSITIVITY .... 15 KHZ

DISPLAY, CRT CA912 11111

DISPLAY REAL-TIME OR VIDEO TAPE DATA.

RESOLUTION .... 625 LINES
FRAME RATE .... 15 FPS

VISICORDER CA914 11111

REAL-TIME RAW DATA RECORDING.

BANDWIDTH .... DC TO 5000 HZ
CHANNELS 16
RECORDING FORMAT .... CRT HARD COPY

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APPENDIX B

EXPERIMENT EQUIPMENT FUNCTIONAL REQUIREMENTS LISTED BY APPENDIX TYPE

```
001000 ACCELEROMETER - SPECIMEN MOVEMENT                          LS901  121111
001000
001000 ORGANISM CONTAINER ACTIVITY AND ACTIVITY LEVEL MONITER.
001000
001000    ACCURACY ..................... +/- 0.0004 G
001000    FREQUENCY RESPONSE ........... 0 TO 100 HZ
001000
001000 ACCELEROMETER,TRIAXIAX                                     ST235   21111
001000
003110 ACOUSTICAL GENERATOR                                       EC013   11111
003110
003110 VARIABLE FREQUENCY AUDIO DRIVERS USED TO POSITION AND CONTROL
003110 WATER DROPLETS OR ICE PARTICLES IN EACH OF THREE MUTUALLY
003110 PERPENDICULAR AXES. EACH DRIVER CAN BE CONTROLLED INDEPENDENTLY
003110 IN FREQUENCY AND AMPLITUDE
003110
003110    FREQUENCY RANGE...............0 TO 10KHZ
003110    AMPLITUDE.....................0 TO TBD DB
003110
003110 ACCUSTIC MIXING AND DISPERSAL UNIT                         SF002   21235
003110
003110 ACCUSTIC SPEAKER                                           ST169   61111
003110
003110 PARTICLE POSITIONING DRIVER
003110
003110    FREQUENCY RANGE............... 50 TO 10KHZ
003110
003210 TRANSDUCER - ACOUSTICAL                                    EC013  241111
003210
003210 MEASURE SOUND INTENSITY LEVEL
003210
003210    INTENSITY LEVEL.............. 0 TO TBD DB
003210
003210 ACCUSTIC TRANSDUCER AND DETECTOR.                          SF004   11111
003210
003210 USE OF SOUND PRESSURE WAVES TO POSITION EXPERIMENT SPECIMEN
003210 SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.
003210
003210    CHAMBER PRESSURE ............ > 0.14 PSI
003210                                  (1 KN/SQ M)
003210                                  < 2E-06 PSI
003210                                  (0.01 N/SQ M)
003210    CONFIGURATION ............... IN APEX OF TETRAHEDRON
003210
003210 AUDIOMETER                                                 LS902   11111
003210
003210 FREQUENCY SOURCE ADJUST IN BOTH FREQUENCY AND AMPLITUDE FOR
003210 EARPHONES OR BONE VIBRATORS
003210
003210    FREQUENCY................125 TO 8000 ADJUSTIBLE IN OCTAVES
003210    ATTENUATOR...............CONTINUOUSLY ADJUSTIBLE IN 1DB STEPS
003210
003210 SOUND LEVEL METER                                          LS923   11111
003210
003210 SOUND LEVEL SURVEYS AND LIMITED FREQUENCY ANALYSIS IN REAL TIME.
003210
003210    FREQUENCY RESPONSE .......... 125 TO 8000 HZ
003210    SOUND LEVEL RANGE ........... 40 TO 100 DB
003210
003210 ACOUSTIC MEASUREMENT DEVICE                                ST214   11114
003210
003210 DEVICE CONSISTS OF AN ACCUSTIC CAVITY, AN OSCILLATOR AND A
003210 DIGITAL DISPLAY
003210
003300 BANDPASS FILTER - WAVE ANALYSIS                            AF912   21111
003300
003300 DETERMINATION OF FREQUENCY AND AMPLITUDE INFORMATION ABOUT THE
003300 CARRIER AND SIDEBANDS.
003300
003300    FREQUENCY RANGE ............. 300 HZ TO 20.0MHZ
003300    ATTENUATION ................. 75 DB
003300    ACCURACY .................... +/- 2 %
003300
003400 DROPLET CLOUD AEROSOL GENERATORS                            EC008   11135
003400
003400 GENERATE AEROSOLS FOR EXPERIMENTATION
003400
003400    PARTICLE CONCENTRATION........10 UP TO 10000/CC
003400    CLOUD FORM....................POLYDISPERSED AND MONODISPERSED
003400    PARTICLE SIZE.................10E-4 TO .1 CM
003400    PRODUCTION RATE...............UP TO 10E5 HZ
003400
003400 LARGE AND GIANT NUCLEI AEROSOL GENERATOR                   EC008   11135
003400
003400 SAME AS DROPLET CLOUD AEROSOL GENERATOR
003400
003400 AITKEN AEROSOL GENERATOR                                   EC008   11135
003400
003400 SAME AS DROPLET CLOUD AEROSOL GENERATOR
003400
003400 GENERATOR - AEROSOL                                        ST046   11135
003400
003400 CAPABILITY TO PRODUCE FINE LIQUID PARTICLES REQUIRED FOR VARIOUS
003400 EXPERIMENTS.  USED IN ST015, ST025 AND ST035.
003400
004100 AIR PARTICLE SAMPLE COLLECTOR                              LS929   11111
004100
004100 AIR PARTICLE AND MICRO-ORGANISM SAMPLES FOR AIR QUALITY DETERMIN-
004100 ATION
004100
004100    AIRFLOW ..................... 1 CU FT/MIN
004100    SAMPLING TIME - CONTINUOUS ... 1 HOUR
004100
004100 AIR SAMPLE UNIT                                            ST105   21111
004100
004100 PERIODIC COLLECTION OF AIR SAMPLES FROM THE SHUTTLE AND ATL
004100 PROVIDING TYPE, RATE OF CHANGE AND QUALIFICATION OF MICRO-
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004100 ORGANISMS AND NON-VIABLE PARTICLES.  USED IN STCIS AND STCAS.
004100
004400 GAS ELIMINATION SYSTEM                                   SF001    11114
004400
004400 REMOVES GASSES PRODUCED BY ELECTROLYSIS IN THE ELECTRODE
004400 COMPARTMENTS OF THE ELECTROPHORETIC COLUMNS
004400
004400    OUTLET OXYGEN CONCENTRATION...      33 (BY VOLUME)
004400    OUTLET HYDROGEN CONCENTRATION.      23 (BY VOLUME)
004400    MAX FLOW RATE..................        1PS
004400    FLOW RATE CONSTANCY............      +-1%
004400    OPERATING TEMPERATURE..........   68 - 77 F (20 - 25 C)
004400
004400 MOLECULAR SIEVE                                           SF001    41137
004400
004400 THE MOLECULAR SIEVE IS USED TO CLEAN GASSES GENERATED IN FURNACES
004400 AND EXHAUSTED TO SPACE. THIS UNIT IS ALSO USED IN THE FURNACE,
004400 GENERAL PURPOSE AND LEVITATION SUPPLEMENTS
004400
004400 CATALYTIC OXIDIZER SYSTEM                                 LS977    11235
004400
004400 REMOVES UNDESIRABLE COMBUSTION PRODUCTS
004400
004400    OPERATING TEMPERATURE.........700F(+700)
004400    AIR FLOW RATE..................20FM AT 14.7PSIA AND 70F
004400
006170 MICROPHONE AMPLIFIER                                      LS100H   11111
006170
006170 AMPLIFY SIGNALS FROM AMPLIFIER
006170
006180 AMPLIFIERS - WAVE ANALYSIS                                AP515    21111
006180
006180 AMPLIFIER - ACOUSTIC GENERATOR                            LF013    11111
006180
006180 AMPLIFY SIGNAL TO ACOUSTIC GENERATOR
006180
006180    POWER............................45W
006180
006185 OPEN R.F. AMPLIFIER T.W.T                                 CN002    51111
006185
008590 ANESTHETIZER - INVERTEBRATES                              LS932    11114
008590
008590 RENDER INVERTEBRATE ORGANISMS INSENSIBLE TO FACILITATE HANDLING.
008590
008590    ANESTHETIC GAS ............... CARBON DIOXIDE
008590
018700 RECEIVER, TELESCOPE                                       LLCPV    1111.
018700
018700 RECEIVES TRANSMITTER RETURNED SIGNALS.
018700
018700    INSTANTANEOUS FOV ............ 0.0018 RAD
018700    POINTING ACCURACY ............ 0.0007 RAD
018700    POINTING STABILITY ........... 0.0007 RAD
018700    POINTING STABILITY RATE ...... 0.0017 RAD PER SEC
018700    POINTING DURATION ............ 7200 SEC
018700
018700 TELESCOPE - TRACKING                                      NEL      1113-
018700
018700 USED FOR HIGH RESOLUTION VIEWING OF SPECIFIC TARGETS
018700
018700    INSTANTANEOUS FIELD OF VIEW...0.[illegible](24X)
018700                                  ...4.0DEG(16X)
018700    FIELD OF VIEW(CROSS-TRACK)....0.9DEG AND 4.0DEG
018700    POINTING ANGLE FROM NADIR
018700      (PITCH, ALONG TRACK).........+70 TO -40DEG
018700    POINTING ANGLE FROM NADIR
018700      (ROLL, CROSS TRACK)..........+/-35DEG
018700    TOTAL ANGULAR COVERAGE (CROSS-
018700      TRACK) FROM NADIR (IFOV/2+
018700      POINTING ANGLE)...............+/-35DEG
018700    POINTING ACCURACY (1-SIGMA)...0.1DEG
018700
018700 TELESCOPE - POINTING                                      ST152    111--
018700
018700 POINTING TELESCOPE WHICH ALLOWS EXPERIMENT PHENOMENA TO BE
018700 OBSERVED AND TRACKED IN SPACE
018700
023500 MASS MEASUREMENT DEVICE - BODY                            LS987    11131
023500
023500 TOTAL BODY MASS DETERMINATION BY OSCILLATING FREQUENCY.
023500
023500    MASS ......................... 125 TO 230 LB.+/-0.1 POUNDS
023500                                   (50 TO 100 KG)
023500
023500 MASS MEASUREMENT DEVICE, MACRO                            LS973    11132
023500
023500 MEASURE MASS OF ITEMS SUCH AS BAGS OF FOOD, BEVERAGE CONTAINERS,
023500 CONTAINERS OF URINE AND FECES, LARGE SPECIMENS, ETC
023500
023500    MASS RANGE....................0.22 TO 44LB (0.1 TO 20KG)
023500
023500 MASS MEASUREMENT DEVICE, MICRO                            LS974    11132
023500
023500 MEASURE SMALL TEST SPECIMENS
023500
023500    MASS MEASUREMENT RANGE.........1MG TO 100 G
023500
034930 AUDIO STEREO HEADSET                                      LS985    11111
034930
034930 EARPHONES FOR VARIOUS PSI HEARING TESTS
034930
039470 CONSOLE, BEHAVIORAL MEASUREMENTS                          LS966    11114
039470
039470 DEVICE THAT MEASURES MENTAL PROCESSES, ATTITUDES, ETC. SUCH AS
039470 COGNITIVE PROCESSES, INDIVIDUAL BEHAVIORAL TRAITS, GROUP
039470 BEHAVIORAL TRAITS, ETC. CONSOLE INCLUDES GENERAL PURPOSE DISPLAY
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Space Division
Rockwell International

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039470 AND GENERAL PURPOSE RESPONCE KEYBOARD
039470
039470    PROCESSES MEASURED.............COMPLEX PERCEPTUAL
039470                       .............CONCEPTUAL AND THINKING ABILITY
039470                       .............MEMORY
039470                       .............REACTION TIME-SIMPLE AND COMPLEX
039470                       .............INDIVIDUAL BEHAVIORAL TRAITS
039470                       .............GROUP BEHAVIORAL TRAITS
039470
039575 LIQUID DROP GENERATOR                                   EC006   41235
039575
039575 GENERATES SINGLE DROPLETS BY MANUAL OR SYSTEM CONTROL. DROPLETS
039575 ARE PROPELLED INTO THE EXPERIMENT CHAMBERS FOR EXAMINATION
039575
039575    FORMATION FREQUENCY(MAX).......10/SEC
039575    DROPLET DIAMETER...............10 MICROMETERS TO 1 CM
039575    DROPLET UNIFORMITY.............WITHIN 5 %
039575
039580 ICE PARTICLE GENERATOR                                  EC007   31235
039580
039580 GENERATE ICE PARTICLES FOR TEST IN ICE DIFFUSION, EXPANSION AND
039580 GENERAL CHAMBERS
039580
039580    ICE CRYSTAL SIZE...............50 MICROMETERS TO 1 CM
039580
039648 VISION TESTER                                           LS981   11235
039648
039648 OPTICAL DEVICE (WITH HOOD AND RESPONSE KEYBOARD) THAT MEASURES
039648 A VARIETY OF VISUAL FUNCTIONS.
039648
042000 CELL COUNTER - BLOOD                                    LS907   11111
042000
042000 MEASURE BLOOD CELL PROPERTIES OF BLOOD SAMPLES. ESSENTIALLY A
042000 COULTER COUNTER
042000
042000    PARAMETERS MEASURED ...........HEMOGLOBIN,HEMATOCRIT,RED BLOOD
042000                                     CELL COUNT,WHITE BLOOD CELL
042000                                     COUNT,MEAN CELL VOLUME,MEAN
042000                                     CELL HEMOGLOBIN AND MEAN CELL
042000                                     HEMOGLOBIN CONCENTRATION
042000    REPRODUCIBILITY................+/-1%
042000
042000 AUTOANALYZER - MULTIPLE                                 LS930   11111
042000
042000 AUTOMATIC ANALYSIS OF BLOOD AND APPROXIMATELY 30 OTHER FLUIDS.
042000
042000 COULTER PRINTER-COUNTER                                 ST084   11111
042000
042000 PROVIDE AUTOMATIC BLOOD ANALYSIS (HEMOGLOBIN, HEMATOCRIT, RED
042000 BLOOD CELL COUNT, WHITE BLOOD CELL COUNT, MEAN CELL VOLUME, MEAN
042000 CELL HEMOGLOBIN AND IT'S CONCENTRATION).  USED IN ST015, ST025
042000 AND ST035.
042000
043000 BLOOD CLOT FIBROMETER                                   LS915   11111
043000
043000 PROVIDE AUTOMATIC MEASUREMENT OF PLASMA COAGULATION TIME
043000
043000    ACCURACY.......................+/-0.1SECOND
043000
043500 CARDIOGRAPH - IMPEDANCE                                 LS100   11111
043500
043500 BLOOD FLOW RATE FROM HEART.
043500
043500    BLOOD FLOW RATE .............. 2 TO 25 LITERS/MIN +/-5 PCT FS
043500
043500 PULMONARY FLOWMETER                                     LS950   11131
043500
043500 BLOOD FLOW RATES AND VOLUME.
043500
043500    FLOW RATE .................... 0 TO 15 L/MIN, +/-3 PCT FS
043500    VOLUME ....................... 0 TO 7 L, +/-3 PCT FS
043500
043500 TRANSCUTANEOUS DOPPLER FLOWMETER                        LS991   11112
043500
043500 MEASURE PULSE WAVE CONTOUR.
043500
043500    ULTRASONIC SIGNAL ............ 1 AND 5 MHZ
043500
048000 PULSE WAVE                                              LS112   11112
048000
048000 MEASURE BLOOD VELOCITY
048000
048000    VELOCITY ..................... 3 TO 15 M/S, +/-0.1 M/S
048000
048050 BLOOD PRESSURE CUFF SYSTEM                              LS978   11132
048050
048050 PRESSURE MEASURING TRANSDUCER CUFF USED TO MEASURE BLOOD PRESSURE
048050 OF PRIMATES.  SYSTEM INCLUDES AIR PUMP FOR AUTOMATED MEASURING,
048050 PRESSURE CUP AND TRANSDUCER, AND SIGNAL CONDITIONER.
048050
048700 REFRIGERATOR                                            SF001   11111
048700
048700 THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES
048700
048700    TEMPERATURE....................32 - 68F (0 - 20C )
048700    LENGTH.........................2FT (60CM)
048700    WIDTH..........................1.8FT (54CM)
048700    HEIGHT.........................2.8FT (84CM)
048700
048700 REFRIGERATOR                                            ST080   11111
048700
048700 PROVIDE A COLD STORAGE AREA TO HOUSE SPECIMEN.  USED IN ST015,
048700 ST025 AND ST035.
048700
048700    TEMPERATURE .................. 3 C (278 K)
048700    SIZE APPROXIMATELY ........... 3 X 2 X 1 FT (76.2X50.7X25.4CM)
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048700
048700 REFRIGERATOR                                           LS959   11111
048700
048700 STORE SERUM AND PLASMA
048700
048700    OPERATING TEMPERATURE.........32 TO 40F(0 TO 4C)
048700    STORAGE VOLUME................1 CU.FT. (0.028 CU.M)
048700
048700 REFRIGERATOR, RADIO ISOTOPE STORAGE                    LS960   11114
048700
048700 STORE LIQUID AND SOLID RADIOACTIVE MATERIALS
048700
048700    OPERATING TEMPERATURE.........41+/-4F(5+/-2C)
048700    VOLUME........................1CU.FT.(0.028CU.M.)
048700    ISOTOPES STORED...............H3,C14,FE55,CR51,I131,CO60
048700
048800 FLUID COOLING/REFRIGERATION UNIT                       SF001   11114
048800
048800 THIS UNIT MAINTAINS THE ELECTROPHORETIC SEPARATION SYSTEM, THE
048800 BUFFER SUPPLY AND SAMPLE AT A CONSTANT LOW TEMPERATURE. IT
048800 CONTROLS THE TEMPERATURE OF THE GAS ELIMINATION SYSTEM. ALSO
048800 IT COOLS (OR HEATS) THE BUFFER/SAMPLE SOLUTION(S) AND THE BUFFER
048800 USED IN THE ELECTRODE COMPARTMENTS OF THE COLUMNS.
048800
048800    CONTROLLED TEMPERATURE RANGE...-13F TO 113F (25 TO 45C)
048800    TEMPERATURE ACCURACY..........+/-1.0F (+/-0.5C)
048800    SYSTEM RECOVERY TIME..........2 MINUTES
048800    MAXIMUM HEAT REJECTION........2KW THERMAL
048800
052570 METABOLIC ANALYZER                                     LS100   111-1
052570
052570 MEASURE O2 CONSUMPTION, CO2 PRODUCTION, MAXIMAL O2 CONSUMPTION
052570 AND ALVEOLAR PO2 AND PCO2.
052570
052570    O2 VOLUME .................... 0 TO 60 L/MIN, +/-3 PCT FS
052570    CO2 VOLUME ................... 0 TO 60 L/MIN, +/-3 PCT FS
052570    ALVEOLAR O2 .................. 20 TO 120 MM HG +/-2 PCT FS
052570    ALVEOLAR CO2 ................. 20 TO 70 MM HG +/-2 PCT FS
052570
052600 DIRECTIONAL CALORIMETER                                SP004   1111-
052600
052600 THE DIRECTIONAL CALORIMETER WILL BE COMPOSED OF A PYROELECTRIC
052600 IR DETECTOR, DETECTOR PREAMPLIFIER, OPTICAL MODULATOR (LIGHT
052600 CHOPPER) AND DEMODULATOR (RECTIFIER). IT WILL BE USED TO
052600 DETERMINE THE BEGINNING OF SOLIDIFICATION BY OBSERVING THE
052600 ACCOMPANYING THERMAL ARREST AND WILL MEASURE THE RATE OF RELEASE
052600 OF THE HEAT OF FUSION.
052600
052600 PYROLYTIC IR DETECTOR SPECTRAL
052600    RANGE.........................2E-5 TO 3E-3 IN(0.5 TO 75
052600                                  MICROMETERS)
052600    INCIDENT FLUX RANGE...........6.5W/IN2 (1 - 10W/CM2)
052600
054000 MOTION PICTURE CAMERA (FAST FRAME)                     FC009   11111
054000
054000 FAST FRAME RATE CAMERA TO RECORD DROPLET COLLISIONS
054000
054000   FRAME RATE.....................100/SEC
054000   RECORDING DURATION.............20SEC
054000   FIELD OF VIEW.................. WIDE ANGLE
054000
054000 TIME LAPSE HIGH SPEED CAMERA                           SF001   21111
054000
054000 CAMERA ALSO USED IN LEVITATION SUPPLEMENT
054000
055050 CAMERA STILL                                           AF810   11111
055050
055050 RECORD EXPERIMENT PHENOMENA
055050
055050    FILM SIZE..................... 35MM
055050    SHUTTER SPEED................. 1 SEC TO 1/500 SEC
055050
055050 CAMERA,STILL                                           AF816   21111
055050
055050 POLAROID CAMERA TO RECORD TRACES ON OSCILLOSCOPE
055050
055050    FILM FORMAT................... POLAROID 107 BLACK/WHITE
055050                                   3.25X4.25IN(82.55X107.95MM)
055050    LENS.......................... 75MM F3.5 TO F22
055050    SHUTTER SPEEDS................ B TO 1/60 SEC
055050    FIELD OF VIEW................. 40 DEGREES
055050
055050 STILL CAMERA                                           FC004   11111
055050
055050 RECORD CLOUD CHAMBER PHENOMENA
055050
055050    FRAME RATE....................2/SEC
055050    SHUTTER SPEED.................1SEC TO 1/500SEC
055050    CAPACITY......................500FRAMES
055050    INTERCHANGABLE LENSES
055050    FILM SIZE.....................35MM
055050
055050 STILL CAMERA                                           FC005   11111
055050
055050 RECORD CLOUD CHAMBER PHENOMENA
055050
055050    SHUTTER SPEED.................1SEC TO 1/500SEC
055050    RESOLUTION....................2 MICROMETERS
055050    DEPTH OF FIELD................1MM
055050    FRAME SIZE....................30MM
055050
055050 CAMERA - STILL FILM (CORE)                             LS565   11111
055050
055050 STILL PHOTOGRAPHIC CAPABILITY WHICH IS SHARED WITH OTHER EXPERI-
055050 MENTS. CAMERA HAS INTERCHANGEABLE LENS AND IS COMPATIBLE WITH
055050 EQUIPMENT SUCH AS MICROSCOPES AND OSCILLOSCOPES.
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055050
055050     FILM FORMAT ....................  35 MM
055050     LENS ...........................  58 MM, F1.2
055050     VIEW ANGLE .....................  41 DEGREES
055050     LENS ...........................  35 MM, F1.8
055050     VIEW ANGLE .....................  64 DEGREES
055050     SHUTTER SPEED ..................  B TO 1/500 SEC
055050     VIEWING ........................  THRU LENS
055050     FOCUS ..........................  SPLIT IMAGE
055050
055050 CAMERA - STILL POLAROID (CORE)                        LS002   41111
055050
055050 POLAROID PHOTOGRAPHIC CAPABILITY SHARED WITH MOST EXPERIMENTS
055050 ALSO ADAPTABLE WITH MICROSCOPE AND OSCILLOSCOPE INTERFACES.
055050
055050     FILM FORMAT ....................  POLAROID 107 BLACK/WHITE
055050                 ....................  3.25X4.25 IN (82.55X192.95 MM)
055050     LENS ...........................  58 MM, F3.5 TO F22
055050     SHUTTER SPEEDS .................  B TO 1/60 SEC.
055050     RANGE FINDER ...................  SPLIT IMAGE
055050     VIEWING ........................  THRU LENS
055050     FIELD OF VIEW ..................  40 DEGREES
055050
055050 CAMERA, PLATE FILM                                    LS538   11111
055050
055050 PROVIDE STILL PHOTOGRAPHIC COVERAGE
055050
055050     FILM TYPES.......................HIGH RESOLUTION GLASS PLATE
055050                ......................STANDARD 2 1/4 X 2 1/4 IN (5.75
055050                                       X 5.75 CM) ROLL
055050                ......................70MM
055050                ......................POLAROID
055050     SHUTTER SPEED....................1 SEC TO 1/500 SEC
055050
055050 CAMERA - STILL (VISIBLE)                              ST020   31111
055050
055050 STILL PHOTOGRAPHIC COVERAGE OF THE EARTH TARGET AREA IN THE
055050 VISIBLE REGION (REQUIRES SIMULTANEOUS PHOTOGRAPH IN THE INFRARED
055050 RANGE). USED IN ST015, ST025 AND ST035.
055050
055050     VIEW ANGLE ..........................  14.5 DEGREES
055050     RESOLUTION .....................  100 LINES/MM
055050     FILM FORMAT ....................  5 INCHES
055050     SHUTTER ........................  B TO 1/8000 SEC
055050
055050 SCOPE CAMERA                                          CN058   21111
055050
055050 OBTAIN FILM RECORD OF DATA AND DISPLAYS.
055050
055050     REDUCTION RATIO ................  1:1, 1:0.7
055050     LENS ...........................  F/1.9 TO F/16
055050     SHUTTER ........................  B TO 5 SECONDS
055050     FILM TYPE ......................  POLAROID
055050
055055 CAMERA - CINE                                         AP829   11111
055055
055055 FILM RECORDER                                         OP002   61121
055055
055055 PROVIDE PHOTOGRAPHIC RECORDINGS TO PROVIDE ALL WEATHER STEREO
055055 IMAGERY FOR TOPOGRAPHIC MAPPING, 3-D STRAIN FIELDS, EROSION, VOL-
055055 CANIC MOTION AND POST-GLACIAL UPLIFT.
055055
055055     FILM TYPE ......................  70 MM
055055     FILM RATE ......................  6 MM/SEC
055055     INSTANTANEOUS FOV ..............  0.0MM RAD
055055
055055 CAMERA CINE                                           LS536   11111
055055
055055 PROVIDE VISUAL RECORDS SUCH AS PHOTOMICROGRAPHY,  TIME LAPSE
055055 RECORDS, PHOTOMICROSCOPY AND GENERAL EXPERIMENT DOCUMENTATION
055055
055055     OPERATION MODE...................VARIABLE FRAME RATE OR SINGLE
055055                                        FRAME PULSE OPERATION UNDER
055055                                        REMOTE CONTROL
055055     FILM SIZE........................16 OR 35MM
055055     LEN SELECTION....................“C” MOUNT LENS SYSTEM: STANDARD
055055                                       ZOOM LENS AS A MINIMUM
055055     EXPOSURE SYSTEM..................AUTOMATIC OR ZOOM
055055     FILM CAPACITY...................  50, 100 OR 200FT (15.2,30.4 OR
055055                                        60.8M) ROLLS
055055
055055 CAMERA - CINE                                         ST054   61111
055055
055055 PHOTOGRAPHIC RECORD OF THE ACTIVITY OF AEROSOL PARTICLES IN
055055 NORMAL, SLOW MOTION AND TIME-LAPSE SEQUENCES
055055 USED IN ST015, ST015, ST035, ST045, ST055 AND ST065.
055055
055055     VIEW ANGLE .....................  40 DEGREES
055055     RESOLUTION .....................  200 LINES/MM
055055     SHUTTER ........................  1/50 TO 1/500 SEC
055055     FILM FORMAT ....................  16 MM
055055     CAMERA SPEED ...................  1, 8, 16, 64 FPS
055055
055055 CAMERA, CINE                                          CN063   11111
055055
055055 PROVIDE PHOTOGRAPHIC RECORD OF TELESCOPE FIELD-OF-VIEW.
055055
055055     FILM FORMAT ....................  35 MM
055055     OPERATION ......................  REMOTE
055055     FRAME RATE .....................  16 FPS
055055     FILM TYPE ......................  COLOR
055055     RESOLUTION .....................  50 LINES/MM
055055     LENS ...........................  100 MM
055055     FIELD OF VIEW ..................  40 DEGREES
055055
067000 CENTRIFUGE                                            ST090   11111
067000
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067000 PROVIDE VARIABLE GRAVITY ENVIRONMENTS TO BIOSCIENCE SPECIMEN
067000 GENERALLY LIMITED TO TEST-TUBE SIZE CONTAINERS.  USED IN ST015,
067000 ST025 AND ST035.
067000
067000    GRAVITY LEVEL INDUCED ........ UP TO 10 G REQUIRED
067000
068000 CENTRIFUGE, MICRO                                     LS942   11111
068000
068000 CENTRIFICAL SEPARATION OF BIOLOGICAL SAMPLES
068000
068000    CAPACITY........................4 SAMPLES
068000    SPEED(MIN)......................1150RPM
068000    GLASS TUBE SIZES............. 0.5 TO 5 ML
068000
068500 CENTRIFUGE,REFRIGERATED,HIGH SPEED                    LS941   11111
068500
068500 SEPARATION EQUIPMENT TO SUPPORT MEDICAL AND BIOLOGICAL RESEARCH.
068500
068500    OPERATING TEMPERATURE..........35 TO 50F (2 TO 10C)
068500    SPEED...........................0 TO 20000RPM
068500
074700 GAS CHROMATOGRAPH                                     SP003   21111
074700
074700 THE FUNCTIONAL REQUIREMENTS OF THE EQUIPMENT ARE TO ANALYZE THE
074700 ATMOSPHERIC COMPOSITION AND THE IMPURITY CONCENTRATION CONTAINED
074700 WITHIN THE EXPERIMENTS' EQUIPMENT ENCLOSURES. THIS ELEMENT IS
074700 ALSO USED ON THE LEVITATION SUBELEMENT.
074700
074700
074700    FLOW RATE ..................... 10 ML/MINUTE
074700    SENSITIVITY.................... 0.1 PPM
074700
074700 GAS CHROMATOGRAPH                                     ST175   21111
074700
074700 ANALYSIS OF COMBUSTION PRODUCTS FOR FLAME CHEMISTRY EXPERIMENTS.
074700 USED IN ST045 AND ST065.
074700
074700 GAS CHROMATOGRAPH                                     LS962   11111
074700
074700 MEASURES CONCENTRATION OF GAS, LIQUID, AND SOLID CONSTITUENTS OF
074700 BIOLOGICAL SAMPLES
074700
074700    OPERATING TEMPERATURE..........-4C TO 752F(-4C TO 400C)
074700    CARRIER GAS.....................HELIUM
074700    DETECTORS.......................HYDROGEN FLAME
074700            ........................THERMAL CONDUCTIVITY
074700    FRACTION COLLECTION SYSTEM
074700
096000 BACTERIAL COLONY COUNTER                              LS908   11111
096000
096000 MANUAL COUNT OF BACTERIAL COLONIES. UNIT IS STANDARD TYPE
096000
096000 AUTOMATIC COLONY COUNTER                              LS952   11111
096000
096000 DETERMINE THE NUMBER OF VIABLE COLONIES GROWING ON AN AGAR
096000 SUBSTRATE
096000
098500 COMBUSTION CHAMBER                                    ST170   11135
098500
098500 CHAMBER WHERE FUELS AND OXIDIZERS ARE INJECTED, ALLOWED TO BURN
098500 AND THE FLAME CAPABLE OF BEING MONITORED.
098500
098500    SIZE APPROXIMATELY ........... 1.67 DIA X 3.5 FT
098500                                   (0.51 DIA X 1.0 M)
098500
098500 COMBUSTION CHAMBER                                    ST202   11135
098500
098500 CHAMBER TO EXAMINE COMBUSTION IN ZERO GRAVITY
098500
098500    DIMENSIONS..................... 1.67FT(0.48M)DIA.X4.0FT(1.22M)
098500
101340 FUNCTION KEYBOARD                                     AS003   11111
101340
101340 ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO
101340 DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY,
101340 FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
101340 ALPHANUMERIC KEYBOARD                                 AS004   11111
101340
101340 ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
101340 FUNCTION KEYBOARD                                     ME003   11111
101340
101340 ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO
101340 DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY,
101340 FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
101340 ALPHANUMERIC KEYBOARD                                 ME004   11111
101340
101340 ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
101340 FUNCTION KEYBOARD                                     SC003   11111
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101340
101340 ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO
101340 DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY,
101340 FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
101340 ALPHANUMERIC KEYBOARD                                SC004    11111
101340
101340 ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
101340 KEYBOARD DISPLAY TERMINAL                            AF819    11111
101340
101340 GENERAL PURPOSE INPUT KEYBOARD ALLOWING FOR PROGRAMING, DATA
101340 INPUT AND UPDATE, AND DATA MANIPULATION FOR ONBOARD ANALYSIS
101340
101340 ALPHANUMERIC KEYBOARD                                EC001    11111
101340
101340 ALLOWS CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS
101340
101340    KEYBOARD.......................TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION.........DIGITAL-32-BIT WORD
101340
101340 MULTIFUNCTION KEYBOARD                               MEC      11111
101340
101340 CONSOLE CONTROL KEYBOARD WITH FUNCTION KEYS LABELLED BY COMPUTER.
101340 A SUPPORTING SOFTWARE LOGIC TREE FOR DATA ENTRY AND DISPLAY CALL
101340 UP CAN BE ENTER AT ANY LEVEL.
101340
101340 CONTROL UNIT - OPERATOR                              SF001    11111
101340
101340 THE OPERATOR'S CONTROL PANEL WILL HAVE THE CAPABILITY OF
101340 CONTROLLING ABOUT 1000 PROCESS LOOPS. DATA MUST BE READOUT ON A
101340 CLICK-LOCK BASIS. IT MUST PROVIDE A WAY TO ENTER NEW PARAMETERS
101340
101340    CHANNEL NUMBER.................3 DIGIT NIXIE(2 EACH)
101340    DATA LEVEL.....................4 DIGIT NIXIE PLUS SIGN(2 EACH)
101340    LOGIC LEVELS, LOGICAL"0" .....0V
101340                  LOGICAL"1" .....5V
101340    DATA OUTPUT....................VARIABLE
101340
101340 KEYBOARD                                             LS910    11111
101340
101340 TYPEWRITER TYPE KEYBOARD USED FOR PROVIDING INSTRUCTIONS FOR THE
101340 COMPUTER
101340
101340 KEYBOARD, COMPUTER                                   CA908    11111
101340
101340 PROVIDES FOR CREWMAN TO COMMUNICATE WITH ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340
101600 PHASE METER, DIGITAL                                 CA004    11111
101600
101600 MEASURES RELATIVE PHASE ANGLES OF RECEIVED SIGNALS FOR INTERFER-
101600 OMETER NAVIGATION/SURVEILLANCE EXPERIMENT.
101600
101600    OUTPUT ........................ GENERATES 13 BIT PHASE MEAS
101600                                    BASED ON TWO 60 MHZ SINUSOIDS
101600                                    AT 10 DBM.
101600    FREQUENCY RANGE ............... 400 MHZ
101600    RESOLUTION .................... 25 KHZ
101600    ACCURACY ...................... +/- 2.5 KHZ
101600
101600 DIGITAL PHASE METER                                  ST011    41111
101600
101600 METER TO DISPLAY PHASE OF SIGNAL RECEIVED BY MICROWAVE
101600 INTERFEROMETER
101600
102500 DIGITAL COMPUTER                                     LS947    11111
102500
102500 PROVIDE AUTOMATIC DATA ACQUISITION OF EXPERIMENTAL DATA, CONTROL
102500 LIGHTING AND ANIMAL FEEDING AND GENERAL LABORATORY ENVIRONMENT
102500 MONITORING. THE COMPUTER WILL SUPPORT ANALYTICAL TOOL SUCH AS
102500 MASS SPECTROMETERS, GAS ANALYZERS AND DIALYSIS EQUIPMENT. ALSO
102500 DRIVES ONE OR MORE CRT INTERACTIVE DISPLAY CONSOLES
102500
102500    MEMORY CAPACITY................16BIT 16,000 WORD
102500    CYCLE TIME.....................1MICROSECOND
102500    PERIPHERAL CAPABILITIES........DIRECT MEMORY ACCESS
102500                           ........FLEXIBLE INTERRUPT STRUCTURE
102500                           ........SINGLE BIT SET AND SENSE LINE
102500                                   CAPABILITY OF UP TO 64 LINES
102500                                   EACH
102500
102700 COMPUTER                                             AP818    21111
102700
102700 COMPUTER CAPABILITY TO  SUPPORT ATMOSPHERIC AND SPACE PLASMA
102700 PHYSICS INVESTIGATIONS.
102700
102700    WORD SIZE ..................... 16 BIT
102700    IP/OP MEMORY TRANSFER.......... 1E+06--16 BIT WORDS/SEC
102700    CORE MEMORY ................... 32E+03 WORDS
102700    IP/OP CHANNELS ................ 45
102700
102700 DIGITAL COMPUTER                                     EC010    11111
102700
102700 PROVIDES DATA PROCESSING AND CONTROL FUNCTIONS FOR THE CFL
102700
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102700 DIGITAL PROCESS PROGRAMMER                              SPOC1    11111
102700
102700    PERFORM PREDETERMINED LOGIC ROUTINES SUCH AS EVENT SEQUENCING.
102700    PARAMETER COMMANDS OR REAL TIME SEQUENCING.
102700
102700 COMPUTER, GENERAL PURPOSE                               CA901    21111
102700
102700 COMPUTER CAPABILITY TO COMMAND EXPERIMENTS ON AND OFF, PROGRAM
102700 EXECUTION OF EXPERIMENT PROCEDURAL STEPS, COMPUTE GIMBAL
102700 ANGLES FOR TELESCOPE AND ANTENNA POINTING, AND COMPUTATION OF
102700 POINT-AHEAD ANGLES.
102700
102700 COMPUTER                                                ST024    21111
102700
102700 COMPUTER CAPABILITY TO PROVIDE BASIC POINTING AND TRACKING INFOR-
102700 MATION RELATIVE TO ATT STABILITY AND FLIGHT PATH REQUIREMENTS.
102700 USED ON ST015, ST035, ST045 AND ST05?.
102700
102750 OPERATIONS CONTROL COMPUTER                             MEC      11111
102750
102750 THE COMPUTER SHALL PROVIDE THE FOLLOWING FUNCTIONS: COMMAND
102750 INTERPRETATION AND EXECUTION, ATTITUDE AND POINTING PROGRAM
102750 CONTROL AND COMPUTATION AND DATA MANAGEMENT SEQUENCING OPERATIONS
102750
102750    MEMORY SIZE....................14550 WORDS
102750    ADD/MULT EXECUTE TIME..........5/30 MICRO SECONDS
102750
103500 MULTIPLEXER A/D CONVERTER                               SPOC1    11111
103500
103500 CONVERT INPUT SIGNAL FRO ANALOG TO DIGITAL FORMAT FOR I/O UNIT
103500
103500    ANALOG INPUT..............    -10.24  TO +10.235V
103500    FULL SCALE ACCURACY.......     +-0.025
103500    RESOLUTION................      12 BITS BINARY
103500    CONVERSION SPEED............. 8 KHZ
103500    DATA OUTPUT.................. 2'S COMPLEMENT
103500
103500 A/D CONVERTER                                           CA062    21111
103500
103500 CONVERT INPUT SIGNAL FROM ANALOG TO DIGITAL FORMAT FOR I/O UNIT
103500
103500 D/A AND A/D CONVERTER                                   CA081    11111
103500
103500 PROVIDES FOR A/D AND D/A CONVERSION.
103500
103500    A/D CONVERTER
103500       SAMPLING RATES ............. 15 MEGASAMPLES/SEC
103500       DATA RATES ................. 105 MBS
103500    D/A CONVERTER
103500       BANDWIDTH .................. 6 MHZ
103500
103500 DATA CONVERTER - ANALOG TO DIGITAL                      ST067    21111
103500
103500 CONVERT ANALOG SIGNAL DATA TO DIGITAL DATE FOR RECORDING AND
103500 LATER DUMPING TO GROUND STATIONS.  USED ON ST015 AND ST035.
103500
103500 ANALOG TO DIGITAL CONVERTER                             LS948    11111
103500
103500 SUPPORT DIGITAL COMPUTER. INCLUDES LO-LEVEL MULTIPLEXER. UNIT
103500 SHOULD BE A PROGRAMMABLE GAIN 12 BIT TYPE
103500
103520 INPUT/OUTPUT STAGE                                      SP001    11111
103520
103520 THE INPUT/OUTPUT UNIT, THROUGH THE USE OF PLUG IN CARDS, CAN
103520 ACCOMODATE A WIDE RANGE OF PROCESS INPUTS AND OUTPUTS FOR MAXIMUM
103520 CONTROL VERSATILITY.
103520
103520    LOGIC LEVELS, LOGICAL "0"..... 0V
103520                  LOGICAL"1"...... 5V
103520    SIGNAL INPUTS..................COMPATIBLE WITH PDP8 TYPE
103520                                   COMPUTERS
103520    SIGNAL OUTPUTS................ 0 - 5V
103520    DATA OUTPUTS...................12 BIT PARALLEL
103520
103520 DATA BIT STREAM GENERATOR                               CA083    11111
103520
103520 PROVIDES TEST BIT STREAMS FOR TRANSMISSION.
103520
103520    DATA RATES .................. 1 TO 105 MBS
103520
103520 DATA PROCESSING EQUIPMENT                               ST035    11111
103520
103520 HIGH SPEED DIGITAL DATA CONVERSION TO ANALOG FORM COMPATIBLE FOR
103520 REAL TIME DISPLAY.  USED ON ST015, ST025 AND ST035.
103520
103520    CHANNELS .................... 32
103520    DIGITAL-DATA ......................... 10E+06 BPS
103520
104000 SUPPORT ELECTRONICS                                     ST006    21114
104000
104000 ELECTRONICS SUPPORT COMMUNICATIONS EXPERIMENTS INCLUDING
104000 MULTIPLEXERS WITH CONVERTERS AND OSCILLATORS
104000
104020 SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE)        AS002    11111
104020
104020 PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT
104020
104020    CHANNELS .................... 2
104020    FORMAT ...................... VIDEO AND DATA
104020    VIDEO INPUT PRESENTATION .... RASTER SCAN
104020    SYMBOL WRITING TECHNIQUE .... STROKE
104020    INTERFACE DESCRIPTION ....... DIGITAL-12-BIT DATAWORD
104020
104020 SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE)        ME002    11111
104020
104020 PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT
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104020
104020    CHANNELS ....................... 2
104020    FORMAT ......................... VIDEO AND DATA
104020    VIDEO INPUT PRESENTATION ..... RASTER SCAN
104020    SYMBOL WRITING TECHNIQUE ..... STROKE
104020    INTERFACE DESCRIPTION ........ DIGITAL-12-BIT DATAWORD
104020
104020 SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE)     SCOC2    11111
104020
104020 PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT
104020
104020    CHANNELS ....................... 1
104020    FORMAT ......................... VIDEO AND DATA
104020    VIDEO INPUT PRESENTATION ..... RASTER SCAN
104020    SYMBOL WRITING TECHNIQUE ..... STROKE
104020    INTERFACE DESCRIPTION ........ DIGITAL-12-BIT DATAWORD
104020
104020 AUTOMATIC DISPLAY GENERATOR                         AFPC9    11111
104020
104020 PROVIDES 3D DISPLAY
104020
104160 PRINTER                                             SPOO1    11111
104160
104160 PRINT RECORDED DATA IN THE FORM OF ALPHA-NUMERIC CHARACTERS
104160 IN HARD COPY FORM UPON REQUEST BY OPERATOR.
104160
104160    FORMAT ......................... PICA TYPE - STANDARD
104160                                     CHARACTERS, NUMBERS SYMBOLS
104160
104160 DIGITAL PLOTTER, PRINTER                            LS9C9    11111
104160
104160 TELEPRINTER                                         CA903    11111
104160
104160 PROVIDES CAPABILITY TO SEND OR RECEIVE TELETYPE MESSAGES.
104160
104160    CHARACTER RATE ................ 30 CHARACTERS/SEC (150 BPS)
104160    CONSISTS OF ................... SOLID STATE KEYBOARD
104160                                     SOLID STATE THERMAL PRINTER
104160                                     EXPANDABLE MESSAGE MEMORY
104160
104180 DISPLAY CRT (CONTROL/DISPLAY CONSOLE)               ASCC1    21111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND
104180 STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180    SCREEN SIZE .................. 14 IN (0.355 M)
104180
104180 DISPLAY CRT (CONTROL/DISPLAY CONSOLE)               HEOC1    21111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND
104180 STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180    SCREEN SIZE .................. 14 IN (0.355 M)
104180
104180 DISPLAY CRT (CONTROL/DISPLAY CONSOLE)               SCOC1    21111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND
104180 STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180    SCREEN SIZE .................. 14 IN (0.355 M)
104180
104180 STATUS PANEL                                        APB20    21111
104180
104180 DISPLAY TERMINAL WITHOUT KEYBOARD PROVIDING STATUS OF EXPERIMENT
104180 FUNCTIONS
104180
104180 SPECIAL DATA ACQUISITION PANEL                      APP21    11124
104180
104180 CRT DISPLAY                                         ECOC1    11111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS,DYNAMIC AND
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180 DIGITAL VISUAL DISPLAY                              ECOC1    11111
104180
104180 DISPLAY NUMERIC DATA
104180
104180 CRT DISPLAY                                         MEC      61111
104180
104180 THE CRT'S ARE LOCATED IN THREE CONSOLES FOR DATA DISPLAY OF
104180 ALPHANUMERICS AND GRAPHICS.
104180
104180    RESOLUTION.....................1000 LINES
104180    CONTROL INPUT FORM.............DIGITAL
104180    SCAN...........................RASTER
104180       ............................CONICAL
104180    PHOSPHOR CHARACTERISTICS......FOUR-COLOR PENETRATION
104180    SCREEN SIZE....................16IN (40CM)
104180    CONTRAST.......................8 GRAY LEVELS
104180
104180 TELEPRINTER                                         SFOO1    11111
104180
104180 CHARACTER ORIENTED CRT TERMINAL. DATA IN THE LINE MEMORY IS
104180 CONVERTED, BY THE CHARACTER GENERATOR, INTO THE APPROPRIATE DOT
104180 PATTERN. THE DOTS ARE SHIFTED OUT OF THE SHIFT REGISTER TO FORM
104180 A VIDEO SIGNAL TO THE MONITOR.
104180
104180    SCREEN FORMATS.................40,72 OR 80 CHARACTERS PER LINE
104180       ........................12 OR 24 LINES
104180    TRANSFER RATE..................110 TO 2400 BAUD, 10 OR 11 BIT
104180                                   CHARACTERS
104180    MODES..........................HALF OR FULL DUPLEX
104180
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104100 DISPLAY, CRT                                            CA912    11111
104100
104100 DISPLAY REAL-TIME OR VIDEO TAPE DATA.
104100
104100    RESOLUTION ..................... 625 LINES
104100    FRAME RATE ..................... 15 FPS
104100
104100 DISPLAY TERMINAL                                        ST020    21111
104100
104100 TERMINAL CONSISTING OF ALPHANUMERIC KEYBOARD AND CRT DISPLAY FOR
104100 MONITORING EXPERIMENT ACTIVITIES
104100
104100 CRT DISPLAY                                             LS951    41111
104100
104100 DISPLAY GRAPHIC AND ALPHANUMERIC DATA
104100
104100
104100 ELECTROPHYSIOLOGY DISPLAY                               LS954    11114
104100
104100 DEDICATED DISPLAY FOR PHYSIOLOGICAL DATA TRANSMITTED BY THE
104100 ELECTROPHYSIOLOGY BACKPACK
104100
104200 SCANNER PROGRAMMER                                      SF001    11111
104200
104200 TRACKS COMPLEX FUNCTION  AND TRANSLATES  IT  INTO A SIGNAL WHICH
104200 DRIVES EXPERIMENT CONTROLLER
104200
104200    ACCURACY......................+-0.5% OF SPAN
104200    REPEATABILITY.................+-0.1 OF SPAN
104200
104360 SCAN PROGRAM GENERATOR                                  CA069    31111
104360
104360 GENERATES DIGITAL CONTROL SIGNALS TO CONTROL RECEIVER SWEEP.
104360 SUPPLIES DIGITAL READOUT OF FREQUENCY AND LEVEL.
104360
104360    BANDS .......................... 24
104360    SCAN TIME ...................... 0.03 TO 300 SECONDS
104360    CAPABILITY ..................... ANALOG DATA COLLECT & DISPLAY
104360
105004 DISK STORAGE SYSTEM                                     LS949    11111
105004
105004 STORES DATA IN SUPPORT OF COMPUTER
105004
105004    STORAGE CAPACITY ..............9.0E6 WORDS
105004
105550 MULTIPLEXER                                             MEC      11111
105550
105550 MULTIPLEX DATA FOR TRANSMISSION VIA SHUTTLE COMMUNICATION LINK
105550
108600 CRYOGENIC COOLER ASSEMBLY                               EC001    11114
108600
108600 PROVIDE LOW TEMPERATURE HEAT SINK TO EXPERIMENT CHAMBERS
108600
108600    MAXIMUM TEMPERATURE............-76F (-60C)
108600    HEAT SINK CAPACITY(EST)........1000BTU (290W THERMAL)
108600
108600 DEWAR                                                   SF001    11111
108600
108600 THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES
108600
108600    TEMPERATURE....................-112F  (-80C)
108600    LENGTH.........................1FT (30CM)
108600    WIDTH .........................1.8FT (54CM)
108600    HEIGHT.........................2.8FT (84CM)
108600
108600 CRYOSTAT (CORE)                                         LS022    11111
108600
108600 CAPABILITY OF STORING QUANTITIES OF CRYOGENIC LIQUID
108600
108600    QUANTITY ....................... 5 GALLONS (0.0019 CU M)
108600    TEMPERATURE .................... -315 F   (-195 C)
108600
108600 FREEZER, CRYOGENIC                                      LS516    11111
108600
108600 PROVIDE A MEANS FOR FREEZING AND STORING BIOLOGICAL SPECIMENS
108600
108600    STORAGE CAPACITY...............115 CU.IN. (1.89LITERS)
108600    OPERATING TEMPERATURE..........-320F(70K)
108600    MIN CRYOGEN HOLDING TIME.......2 WEEKS BETWEEN REFILLS
108600
108600 CRYOSTAT - HELIUM                                       ST152    11111
108600
108600 DEWAR TYPE STORAGE CONTAINER TO STORE AND DISPENSE LIQUID HELIUM.
108600
108600    SIZE APPROXIMATELY ............. 1.5 DIA X 1.7 FT
108600                                     (0.5 DIA X 0.05 M)
108600
110300 BIT ERROR COUNTER                                       CA074    11111
110300
110300 COUNT ERROR PULSES OUTPUTED BY THE BIT ERROR DETECTOR TO DETER-
110300 MINE THE BIT ERROR RATE OF THE DIGITAL TRANSMISSION SYSTEM.
110300
130000 DIALYSIS UNIT                                           SF001    11113
130000
142000 DYNAMOMETER                                             LS103    11133
142000
142000 MEASUREMENT OF FORCE OR POWER.
142000
142000    ARM FLEXION .................... 25 TO 75 LB (10 TO 35 KG)
142000    BACK EXTENSION ................. 100 TO 200 LB (40 TO 80 KG)
142000
143500 ECG/VCG                                                 LS101    21131
143500
143500 MONITOR HEART CONDITION.  ELECTRO/VECTORCARDIOGRAPH.
143500
143500    SENSITIVITY .................... 0 TO 3 MV +/-1 PCT FS
143500    HEART RATE ..................... 40 TO 180 BEATS/MIN
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143500
143500 PHONOCARDIOGRAM                                        LS106    11111
143500
143500 AURAL MONITOR OF HEART BEAT.
143500
143500    SENSITIVITY ................... 0.1 TO 1000 HZ, +/-5 PCT FS
143500
144500 EEG - ELECTROENCEPHALOGRAPH                            LS102    11131
144500
144500 MONITOR ELECTRICAL IMPULSES GENERATED BY THE BRAIN.
144500
144500    SENSITIVITY ................... 10 TO 200 MICROVOLTS +/-1 PCTFS
144500    FREQUENCY RESPONSE ............ 0.2 TO 100 HZ
144500    CHANNELS ...................... 6
144500
145500 EMG - ELECTROMYOGRAM                                   LS104    11131
145500
145500 MONITOR THE MOVEMENT OF THE BODY MUSCULAR SYSTEM.
145500
145500    SENSITIVITY ................... 0.01 TO 5 MV +/-1 PCT FS
145500    BANDWIDTHS .................... 0.5 TO 200 HZ, 0.5 TO 1000 HZ
145500    CHANNELS ...................... 1
145500
146915 ANTHROPOMETRIC GRID                                    LS923    11111
146915
146915 ANTHROPOMETRIC MEASUREMENTS OF VERTEBRATES EITHER REMOTELY OR
146915 AUTOMATICALLY.
146915
146915    SMALL GRID .................... 5 X 15 CM SPACED AT 1 MM
146915    MEDIUM GRID ................... 50 X 75 CM SPACED AT 2 MM
146915    LARGE GRID .................... 2 X 2 M SPACED AT 5 MM
146915
149300 ELECTROPHORESIS APPARATUS                              ST008    11111
149300
149300 MEASURE ELECTROPHORESIS MOBILITY, SURFACE-ZETA POTENTIAL, AND
149300 SURFACE CHARGE DENSITY OF CELL LINES OVER THEIR LIFE CYCLE.  USED
149300 IN ST015 AND ST025.
149300
149378 CONTINUOUS FLOW ELECTROPHORETIC COLUMN WITH PUMP    SP001    11114
149378
149378 THIS UNIT SEPARATES BIOLOGICAL SAMPLES BY ELECTROPHORESIS.
149378 RELATIVELY LARGE SAMPLES, APPROXIMATELY 10 CC, WILL BE PROCESSED.
149378 SAMPLE AND BUFFER FLOW WILL BE CONSTANT AND SAMPLE FRACTION
149378 COLLECTION CONTINUOUS.
149378
149378    TOTAL BUFFER AND SAMPLE VOLUME..    6CU.IN. (100000)
149378    OPERATING TEMPERATURE..........    14 TO 41 F(-10 TO 5C)
149378    OPERATING TEMPERATURE REGULATION        +/-2F (+/-1C)
149378    SEPARATION PROFILE ACCURACY...          +/-.004IN(+/-.1MM)
149378    POSITION MONITOR ACCURACY.....          +/-.004IN(+/-.1MM)
149378    FRACTION OUTLET PORT LOCATION ACCURACY  +/-.004IN(+/-.1MM)
149378    INPUT VOLTAGE..................              500DV
149378
149390 STATIONARY ELECTROPHORETIC COLUMNS                     SP001    11114
149390
149390 THE STATIONARY ELECTROPHORETIC COLUMNS HAVE THE ANTICIPATED
149390 USAGES: (A)TO ESTABLISH PROCESSING AND OPERATING PARAMETERS FOR
149390 THE CONTINUOUS ELECTRORETIC COLUMNS, AND (B) FOR SMALL BATCH
149390 PROCESSING (APPROXIMATELY 0.100(.006 IN**3)) OF VARIOUS
149390 BIOLOGICAL COMPONENTS
149390
149390    TOTAL BUFFER AND SAMPLE VOLUME ....1.5CU.IN. (25CC)
149390    SEPARATION VELOCITY ACCURACY..     +/-0.04IN (+/-1MM)
149390    POSITION MONITOR ACCURACY.....     +/-0.04IN (+/-1MM)
149390    OPERATING TEMPERATURE RANGE...     14 TO 41F (-10 TO 5C)
149390    TEMPERATURE TOLERANCE.........     +/-2F (+/-1C)
149390
152500 ELECTROPHORESIS APPARATUS                              LS956    11111
152500
152500 SEPARATES PROTEIN AND AMINO ACID CONSTITUENTS IN SERUM,PLASMA,
152500 URINE OR SPINAL FLUID FOR QUANTITATIVE ANALYSIS.
152500
152500    VOLTAGE.......................0 TO 500 V DC
152500    SUBSTRATE.....................STARCH BLOCK, PAPER OR GEL
152500    SAMPLE VOLUME.................0.001 TO ML
152500
159100 CONDITIONING CHAMBER                                   EC015    11134
159100
159100 THE CONDITIONING CHAMBER IS MADE UP OF A PRESSURE SHELL, A
159100 POSITIVE EXPULSION REGULATOR AND A WV AEROSOL CONDITIONER. THIS
159100 CHAMBER CONDITIONS THE GAS SAMPLE PRIOR TO ITS INJECTION INTO
159100 THE CLOUD CHAMBER
159100
159100    OPERATING PRESSURE(EST).......20PSIA (14E03N/M2)
159100    OPERATING TEMPERATURE.........32 TO 86F (0 TO 30C)
159100    VOLUME........................2 CU.FT. (0.0565 CU. METERS)
159100
159310 EXERCISER/ERGOMETER - PRIMATE                          LS175    11133
159310
159310 PRIMATE EXERCISER AND WORKLOAD MEASURING DEVICE.
159310
159400 ERGOMETER - BICYCLE                                    LS986    11131
159400
159400 WORKLOAD MEASURING DEVICE.
159400
159400    LOAD RANGE .................... 0 TO 300 WATTS, +/-2 PCT FS
159400    ROTATIONAL SPEED .............. 40 TO 90 RPM
159400
164000 MICROFILM VIEWER                                       AS005    11111
164000
164000 PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-
164000 SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES,
164000 SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.
164000
164000    FILM FORMAT ................... 16 MM DUAL TRACK
164000    FILM LOADING .................. CASETTE
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164000    FILM SLEWING .................... MANUAL AND COMPUTER SELECT
164000    INTERFACE DESCRIPTION ......... DIGITAL 13-BIT BINARY
164000
164000 MICROFILM VIEWER                                    HE005   11111
164000
164000 PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-
164000 SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES,
164000 SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.
164000
164000    FILM FORMAT ..................... 16 MM DUAL TRACK
164000    FILM LOADING .................... CASETTE
164000    FILM SLEWING .................... MANUAL AND COMPUTER SELECT
164000    INTERFACE DESCRIPTION ......... DIGITAL 13-BIT BINARY
164000
164000 MICROFILM VIEWER                                    SC005   11111
164000
164000 PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-
164000 SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES,
164000 SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.
164000
164000    FILM FORMAT ..................... 16 MM DUAL TRACK
164000    FILM LOADING .................... CASETTE
164000    FILM SLEWING .................... MANUAL AND COMPUTER SELECT
164000    INTERFACE DESCRIPTION ......... DIGITAL 13-BIT BINARY
164000
164000 MICROFICHE READER                                   MFC     11111
164000
164000 READER CONCURRENTLY DISPLAYS SEQUENCES OF MICROFILM RECORDS OF
164000 MAPS, REFERENCE SIGNATURES AND OTHER MATERIALS NEEDED FOR
164000 REAL TIME EVALUATION OF SENSOR FORMATS SELECTED FOR CRT DISPLAY
164000
164000    STORAGE CAPACITY................33,000PAGES
164000    RETRIEVAL SPEED.................4 SECONDS MAX
164000    INTERFACE.......................STANDARD COMPUTER
164000
171600 TASKBOARD - FORCE/TORQUE                            LS925   11131
171600
171600 MEASURE MAN'S CAPABILITY TO APPLY FORCES AND TORQUES IN A VARIETY
171600 OF DIRECTIONS FROM VARIOUS HAND/BODY ORIENTATIONS AND RESTRAINT
171600 CONDITIONS.
171600
171600    HAND FORCE APPLICATIONS ...... +/- 0.5 POUNDS
171600
172500 FLOW METER, GAS                                     LS992   11111
172500
172500 MEASURE AIR FLOW
172500
173000 FLOW METER                                          SP001   11111
173000
173000 GAS FLOW METERING AND MONITORING DEVICE.
173000
173000    GAS TYPE ........................ OXYGEN, NITROGEN, HELIUM
173000    GAS FLOW RATE ................... 0.4 TO 0.3 LB/HR
173000                                      0.3 TO 3.0 LB/HR
173000
173000 FLOW METER, WATER MANIFOLD                          LS989   11235
173000
173000 IN LINE MEASUREMENT OF WATER FLOW, GENERALLY A LOW RATE
173000 ASSOCIATED WITH WATER CONSUMPTION BY ORGANISMS
173000
177000 FRACTION COLLECTION SYSTEM                          SP001   11235
177000
177000 THIS APPARATUS WILL HAVE TWO FUNCTIONS: (1) TO COLLECT THE
177000 DESIRED FRACTIONS AFTER SEPARATION, AND (2) TO REMOVE THE EXCESS
177000 BUFFER SOLUTION AND REMAINING UNWANTED SAMPLES
177000
177000    PUMP TYPE.....................POSITIVE DISPLACEMENT
177000                            1.8 CU.IN/MIN (30 CC/MIN)
177000    PUMPING RATE ACCURACY.......+-0.1%
177000    ALLOWABLE PUMP PULSATION......0.01PSI (+/-70 N/M2)
177000    TEMPERATURE REGULATION........+/-1.0F (+/-0.5C)
177000
178200 FREEZER                                             SP001   11111
178200
178200 THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES
178200
178200    CONTROLLED TEMPERATURE RANGE..-13F TO 113F (-25C TO 45C)
178200    LENGTH........................1FT (30CM)
178200    WIDTH.........................1.8FT (54CM)
178200    HEIGHT........................2.8FT (84CM)
178200
178200 FREEZER, GENERAL                                    LS957   11111
178200
178200 STORAGE OF SERUM, PLASMA, SPECIMENS AND ORGANISMS
178200
178200    OPERATING TEMPERATURE..........-4F (-20C)
178200    TEMPERATURE TOLERANCE..........+/-4F(+/-2C)
178200    STORAGE VOLUME.................4 CU. FT. (0.11CU.M.)
178200
178200 FREEZER, LOW TEMP                                   LS958   11111
178200
178200 STORAGE OF EXPERIMENT SPECIMENS
178200
178200    OPERATING TEMPERATURE..........-94F(-70C)
178200    STORAGE VOLUME.................1 CU.FT. (0.028 CU.M.)
178200
179500 SPECTRUM ANALYZER                                   AP003   41111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE RATIO AND
179500 MULTIPLE RATIO OF VARIOUS FREQUENCY SOURCES.
179500
179500    BANDWIDTH ...................... 20 HZ TO 300 KHZ
179500    SENSITIVITY .................... 20 NANOVOLTS
179500    ACCURACY ....................... +/- 0.6 DB
179500
179500 PULSE WAVE ANALYZER- C.W. MODES                     AP913   11111
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179500
179500 MULTI-CHANNEL ANALYZER                                  AFRC4   11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE RATIO AND
179500 MULTIPLE RATIO OF MULTIPLE FREQUENCY SOURCES SIMULTANEOUSLY.
179500
179500     BANDWIDTH ..................... 0 TO 10 MHZ
179500     TIME BASE ..................... 200 MHZ CLOCK
179500     MEMORY SIZE ................... 1024, 4096, 8192 CHANNELS
179500
179500 WAVE ANALYZER                                           AFRC5   11111
179500
179500 DETECTION OF SIGNAL AMPLITUDE AND FREQUENCY INFORMATION
179500
179500     BANDWIDTH ..................... 10 TO 600 KHZ
179500     FREQUENCY RESOLUTION .......... 10 HZ
179500     SENSITIVITY ................... 3 MV TO 30 V FS
179500     CHANNELS ...................... 2 MINIMUM
179500
179500 WAVE ANALYZER                                           APRC6   11111
179500
179500 DETERMINE ,SEPARATE AND ANALYZE VARIOUS FREQUENCY COMPONENTS OF
179500 INPUT SIGNALS (I.E. FUNDAMENTAL, HARMONICS, INTERMODULATION PRO-
179500 DUCTS, ETC.).
179500
179500     BANDWIDTH ..................... 1 KHZ TO 1.5 MHZ
179500     FREQUENCY RESOLUTION .......... +/- 1.0 %
179500     SENSITIVITY ................... 10 MV TO 100 V
179500     CHANNELS ...................... 2 MINIMUM
179500
179500 FREQUENCY COUNTER                                       AFEC6   11111
179500
179500 DIRECT MEASUREMENT OF FREQUENCY AND/OR SIGNAL REPETITION RATE.
179500
179500     BANDWIDTH ..................... 0 TO 35 MHZ
179500     SENSITIVITY ................... 10 MV RMS
179500     TIME BASE ..................... 100KHZ TO 10 MHZ
179500
179500 ANALYZER - MULTICHANNEL                                 EC011   11111
179500
179500 ALLOW SELECTIVE ANALYSIS OF COUNTER DATA
179500
179500 FREQUENCY COUNTER                                       CA059   11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE, TIME INTERVAL
179500 AND RATIO OF FREQUENCY SOURCES.
179500
179500     BANDWIDTH ..................... 3 HZ TO 10 MHZ
179500     SENSITIVITY ................... 0.01 RMS
179500     TIME BASE ..................... INTERNATIONAL SECOND
179500
179500 SPECTRUM ANALYZER/OSCILLOSCOPE                          CA500   21111
179500
179500 SINGLE DESIGN FUNCTIONS AS POWER SPECTRAL DENSITY AND WAVEFORM
179500 DISPLAY FOR QUICKLOOK AND AS MODULATION MONITOR.
179500
179500     BANDWIDTH ..................... 18 GHZ
179500     SENSITIVITY ................... 2 MV/DIVISION
179500     CHANNELS....................... 2
179500     PHOTOGRAPHIC CAPABILITY ....... YES
179500
179500 SPECTRUM ANALYZER                                       ST017   11111
179500
179500 SUPPORT SETUP, CHECKOUT AND SIGNAL OUTPUT ANALYSIS OF RF RADIO-
179500 METER UNIT AND.SWEEP RECEIVER (CRT DISPLAY OF SWEEP RECEIVER AMP-
179500 LITUDE VERSUS FREQUENCY).
179500 USED IN ST015 AND ST025.
179500
179500     BANDWIDTH ............................ 30 TO 10000 MHZ
179500     RESOLUTION .................... 2 %
179500     SENSITIVITY ................... 10 MV/DIVISION
179500
179500 FREQUENCY METER                                         ST156   11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD, AVERAGE RATIO AND
179500 MULTIPLE RATIO OF VHF FREQUENCY SOURCES.  USED ON ST035.
179500
179500     BANDWIDTH ............................ 10 TO 100 MHZ
179500     SENSITIVITY ................... +/- 2 %
179500
181000 FREQUENCY SYNTHESIZER - WAVE ANALYSIS                   AFS16   21111
181000
181000 TRANSLATION OF A STABLE FREQUENCY OF A PRECISE STANDARD TO ANY OF
181000 A SELECTED INVESTIGATION REQUIREMENT.
181000
181000     FREQUENCY BANDWIDTH ........... DC TO 13 MHZ IN 5 RANGES
181000     FREQUENCY RESOLUTION .......... 0.01 TO 10 MHZ
181000     FREQUENCY STABILITY ........... 1E-07 PARTS PER DAY
181000
181000 SIGNAL GENERATOR                                        LS052   11111
181000
181000 ACCURATELY REPRODUCE SELECTED FREQUENCIES AS REFERENCES FOR PUR-
181000 POSES OF MAINTENANCE AND REPAIR.
181000
181000     BANDWIDTH ..................... DC TO 20 MHZ
181000     OUTPUT VOLTAGE ................ 3 V TO 0.1 MV
181000
181000 FREQUENCY SYNTHESIZER AND DRIVER                        CA056   11111
181000
181000 RECEIVER FIRST LOCAL OSCILLATOR.
181000
181000     FREQUENCY ..................... DC TO 500 MHZ
181000     STABILITY ..................... +/- 5E-11 PER DEG C
181000     OUTPUT VOLTAGE ................ 1 V RMS  +/- 1.5 DB
181000
181000 CALIBRATION SIGNAL GENERATOR                            CA091   11111
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101000
101000 CALIBRATES RECEIVER SENSITIVITY AND PHASE METER.
101000
101000    FREQUENCY RANGE ............... 1565.75 TO 1570.25 MHZ
101000    FREQUENCY ACCURACY ............ +/- 5 MHZ
101000    FREQUENCY STABILITY ........... 0.005 %/DEGREE C
101000    RF OUTPUT POWER ............... +10 DB TO -127 DB
101000
101000 SIGNAL GENERATOR                                    ST016    11111
101000
101000 ACCURATELY REPRODUCE IN PULSE FORM THE OUTPUT OF A MICROWAVE
101000 RADIOMETER MONITORING SEA SURFACE STATE AND TEMPERATURE.
101000 USED IN ST015.
101000
101000    REPITION RATE ................. CW
101000    OUTPUT VOLTAGE ........................ +/- 5 VDC
101000
103900 RF INDUCTION COILS                                  SP004    11111
103900
103900 PROVIDE NON-CONTACT HEATING
103900
103900    FREQUENCY RANGE................2KHZ TO 2MHZ
103900    OPERATIONAL ATMOSPHERE.........ANY
103900
104000 MICROWAVE HEATER                                    SP002    31235
104000
104000 PROVIDE MICROWAVE ENERGY SOURCE FOR SPECIMEN HEATING
104000
104000    TEMPERATURE(MAX)...............18000F (10,000C)
104000    POWER(MAX).....................2KW
104000    FREQUENCY RANGE(MAX)...........UP TO 1010 HZ
104000    OPERATIONAL ATMOSPHERE.........ANY BUT VACUUM
104000
104500 RESISTANCE HEATER (CONTACT)                         SP002    21111
104500
104500 HEATING ELEMENT WHICH HEATS ENCAPSULATED SAMPLES BY PASSING A
104500 CURRENT THROUGH IT
104500
104500    POWER..........................4KW SUSTAINED, 9KW PEAK
104500    TEMPERATURE(MAX)...............2900F (1600C)
104500    ATMOSPHERE.....................INERT GAS OR VACUUM
104500
104500 RESISTANCE HEATER (NON-CONTACT)                     SP004    11111
104500
104500 TUBE TYPE HEATING UNIT FOR USE IN CHEST-GENERAL PURPOSE ENCLOSURE
104500 OR HOT WALL FURNACE
104500
104500    POWER..........................4KW SUSTAINED, 9KW PEAK
104500    TEMPERATURE(MAX)...............2900F (1600C)
104500    SPECIMEN SIZE..................4IN (10CM)LONG X 0.75 IN(2CM)
104500                                   DIA.
104500
105450 DIRECTIONAL SOLIDIFICATION UNIT                     SP002    11114
105450
105450 THIS UNIT CONSISTS OF A FURNACE AND A CHILL UNIT. SPECIMENS ARE
105450 HEATED, MOVED THROUGH A THERMAL GRADIENT AREA AND THEN INTO A
105450 COOLING AREA.
105450
105450    CHILL UNIT DIMENSIONS..........0.6 IN(1.5CM)I.D.X8.0 IN(20CM)
105450                                   LONG
105450    CHILL CAPACITY.................1KW THERMAL
105450    HEATING UNIT DIMENSIONS........0.8 IN(2CM)I.D.X8IN(20CM) LONG
105450    HEATER CAPACITY................1KW THERMAL
105450    TEMPERATURE GRADIENT ADJUST
105450          RANGE....................5 TO 500F/IN (2 TO 200C/CM)
105450    HEATER MAX TEMPERATURE.........2900F(1600C)
105450    CHILL UNIT MIN TEMP............40 TO 77F (2C TO 25C)
105450    EXTERNAL SURFACE TEMP..........60 TO 110F (15 TO 50C)
105450
106000 HOT WALL TUBE FURNACE                               SP002    31111
106000
106000 THIS  UNIT  IS A GENERAL PURPOSE,HOT WALL HEATING DEVICE
106000 PROVIDING ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH
106000 RESPECT TO A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.
106000
106000    VACUUM LEVEL...................2E-8 PSI (195E-4N/M2)
106000    OPERATING TEMPERATURE..........2200F (1200C)
106000    MAX EXTERNAL SURFACE TEMP......110F (45C)
106000    HOT ZONE DIMENSIONS............2.5 IN (6CM) DIA. X 6IN(15CM)LNG
106000    MAXIMUM DEVIATION FROM FLAT
106000       PROFILE.....................+/-4F (+/-2C)
106000
106000 HOT WALL FURNACE                                    SP002    21111
106000
106000 THIS UNIT IS A GENERAL PURPOSE, HOT WALL HEATING DEVICE PROVIDING
106000 ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH RESPECT TO
106000 A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.
106000
106000    VACUUM LEVEL...................2E-8 PSI (1.5E-4N/M2)
106000    OPERATING TEMPERATURE..........3300F (1800C)
106000    EXTERNAL SURFACE TEMPERATURE...110F (45C)
106000    HOT ZONE DIMENSIONS(MIN).......1IN. (2.5CM)DIA.X5IN.(13CM)LONG
106000    MAXIMUM DEVIATION FROM FLAT
106000         PROFILE...................+/-7F (+/-4C)
106000    VIEWPORTS......................2
106000
106000 CHEST-GENERAL PURPOSE ENCLOSURE                     SP002    31113
106000
106000 THE PRIMARY FUNCTION OF THE ENCLOSURE IS TO ISOLATE THE HEATED
106000 SPECIMEN FROM THE LABORATORY ENVIRONMENT, BOTH THERMALLY AND
106000 ATMOSPHERICALLY, AND TO PROVIDE A MEANS TO STRUCTURALLY ATTACH
106000 THE VARIOUS HEATING ELEMENTS AND ACCESSORY ITEMS
106000
106000    VACUUM LEVEL...................2E-10PSI (1.5E-6N/M2)
106000    MAXIMUM INTERNAL TEMP..........5400F (3000C)
106000    MAX EXTERNAL SURFACE TEMP......110F (45C)
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186000     HOT ZONE DIMENSIONS(MIN)......1IN.(2.5CM)DIA.X4IN(10CM) LONG
186000     FULL LENGTH FRONT OPENING DOOR
186000     VIEW PORTS....................FRONT,REAR,2 SIDES,BOTTOM,TOP
186000     FLANGE OPENINGS...............TOP,BOTTOM,2 EACH SIDE,2 REAR
186000
186000 ZONE REFINER                                              SF002    11112
186000
186000 THIS UNIT WILL HEAT, HOLD AND MANIPULATE A SPECIMEN FOR ZONE
186000 REFINING AND MOLTEN ZONE CRYSTAL GROWTH. IT WILL CAUSE A MOLTEN
186000 REGION TO TRAVERSE ALONG A LONG CYLINDRICAL ROD OF MATERIAL.
186000
186000     SPECIMEN SIZE.................4 TO 12 IN (10 TO 30 CM) LONG
186000                                   0.1 TO 0.5IN(0.25 TO 1.25CM) DIA
186000     SCANNING DISTANCES............UP TO 12IN(30CM)
186000     SCANNING SPEED................UP TO 20IN/MIN (50CM/MIN)
186000     SPECIMEN ROTATION.............0 TO 60 RPM
186000     OPERATING TEMPERATURE.........575 TO 2900F (300 TO 1600C)
186000
186000 GRADIENT FURNACE                                          SF002    11113
186000
186000 THERMAL OVEN                                              SF003    21111
186000
186000 OVEN                                                      LS027    21111
186000
186000 CAPABILITY TO HEAT, MAINTAIN CONSTANT TEMPERATURE, AND DRY TEST
186000 EQUIPMENT, LIQUIDS AND TEST SPECIMEN.
186000
186000     TEMPERATURE RANGE ............ 32 TO 450 F (0 TO 232 C)
186000     CAPACITY ..................... 1 CU FT (0.03 CU M)
186000
187000 BENCH, LAMINAR AIRFLOW                                    LS924    11114
187000
187000 A GLOVE BOX WITH RELATIVELY HIGH AIR FLOW FOR CONTROL OF
187000 PARTICULATE AND GASEOUS CONTAMINANTS WITHIN
187000
187000 BENCH, GENERAL EXPERIMENTS                                LS925    11134
187000
187000 PROVIDE WORK AREA FOR PREPARATION OF EXPERIMENTS, EXPERIMENT
187000 MAINTENANCE OBSERVATIONS, AND PREPARATIONS FOR RETURN TO EARTH
187000
187000     ELECTRICAL UTILITY............28VDC, 400HZ AC, 60HZ AC
187000     VACUUM UTILITY................10E-6 TORR
187000     PRESSURE SOURCE...............50 PSIG (3.45E4 N/M2)
187000     AVAILABLE GASSES..............OXYGEN, NITROGEN, CARBON DIOXIDE
187000
187000 WORK BENCH                                                ST182    21114
187000
187000 PROVIDE A WORK AREA UPON WHICH EXPERIMENTS AND MAINTENANCE MAY BE
187000 PERFORMED.  ENCLOSED STORAGE TO BE INCORPORATED IN BENCH.  USED
187000 ON ST01S, ST02S, ST03S, ST04S AND ST06S.
187000
187000     SIZE APPROXIMATELY ........... 2X3X4 FT (0.61X0.91X1.2 M)
187000
187110 LITTER CHAIR - ROTATING                                   LS114    11131
187110
187110 GRAVITY INDUCING DEVICE AND HORIZONTAL WORK TABLE.
187110
187110     ROTATION SPEED ............... 0 TO 60 RPM
187110
201000 ULTRASONIC CLEANER (CCPL)                                 LS047    11111
201000
201000 HIGH FREQUENCY ENERGY FOR CLEANING EXPERIMENT AND MAINTENANCE
201000 EQUIPMENT.
201000
201000     OPERATING FREQUENCY .......... 20000 HZ
201000     CAPACITY ..................... 1 CU FT
201000
204200 HEAT EXCHANGER                                            EC001    11121
204200
204200 EXCHANGER TO TRANSFER HEAT FROM THE CLOUD PHYSICS LAB TO THE
204200 SPACELAB HEAT REJECTION SUBSYSTEM
204200
204200     HEAT TRANSFER RATE............185 BTU/HR (54 WATTS THERMAL)
204200     SPACELAB COOLANT INLET TEMP...43F (6C)
204200     CPL COOLANT OUTLET TEMP.......45F (7C)
204200
205000 HEAT EXCHANGER                                            EC001    11121
205000
205000 PROVIDE HOT FLUID TO CPL
205000
205000     CPL COOLANT OUTLET TEMP.......100F (38C)
205000     HEAT RATE (EST)...............170BTU/HR (50 WATTS THERMAL)
205000
207500 HEMATOCRIT, ELECTRONIC                                    LS917    11111
207500
207500 AUTOMATICALLY DETERMINE THE PERCENT HEMATOCRIT IN BLOOD. RAPID %
207500 READOUT AND TEMPERATURE COMPENSATOR REQUIRED
207500
211000 HUMIDIFIER ASSEMBLY                                       EC003    11135
211000
211000 THIS ASSEMBLY CONSISTS OF AN EVAPORATOR, A HEATER, A WATER TRAP,
211000 A METERING PUMP AND A WATER TANK WITH AN INTEGRAL BLADDER. THIS
211000 ASSEMBLY GENERATES THE WATER VAPOR NECESSARY FOR CLOUD CREATION.
211000
211000     DRY AIR FLOW RATE.............175CFM (5 LITERS/MIN)
211000     MAXIMUM TEMPERATURE...........77F (45C)
211000     HUMIDITY RANGE................0 TO 100%
211000     HEATER CAPACITY(MIN)..........17BTU/HR (5W THERMAL)
211000     HEATER FEED RATE (MAX) ....... 0.02 LB/HR (9.1 CC/HR)
211000     WATER TANK CAPACITY...........3LBS (1.35KG)
211000
211000 VAPORIZER - WATER                                         ST048    21135
211000
211000 CAPABILITY TO PROVIDE COOL WATER VAPOR TO EXPERIMENT CONTAINER.
211000 USED IN ST01S, ST02S AND ST03S.
211000
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211000 STEAM GENERATOR                                   ST101    11135
211000
211000 DEVISE TO GENERATE STEAM IN ZERO GRAVITY
211000
211300 DEW POINT SENSOR                                  EC003    11112
211300
211300 THIS SENSOR MEASURES THE DEW POINT OF THE GAS SAMPLE
211300
211300    MEASUREMENT RANGE.............10 TO 588
211300    ACCURACY......................+/-1%
211300
211300 LIQUID WATER CONTENT METER                        EC003    11235
211300
211300 MONITORS LIQUID WATER CONTENT WITHIN THE EXPANSION CHAMBER FOR
211300 THE PURPOSE OF ACCURATE WATER BUDGET ACCOUNTS. CURRENT CONCEPTS
211300 USE OPTICAL TECHNIQUES TO MEASURE THE WATER DROPLETS IN AIR.
211300
211300    ACCURACY......................+/-0.05%
211300
211300 DROPLET SIZE DISTRIBUTION METER                   EC009    11235
211300
211300 THIS UNIT WILL DETERMINE DROPLET SIZE DISTRIBUTIONS WITHIN A
211300 CHAMBER UTILIZING OPTICAL TECHNIQUES
211300
211300 GAS ANALYZER, WATER VAPOR                         LS563    11111
211300
211300 MONITOR WATER VAPOR CONTENT
211300
211300    MOISTURE RANGE................0 TO 58% RELATIVE HUMIDITY
211300                                  (0.001 TO 20000MICROGRAMS/LITER)
211300    TEMPERATURE RANGE.............-166 TO 140F (-110 TO 60C)
211300
217500 RECIRCULATING FLUID INCUBATOR                     SF001    11112
217500
217500 CELLS/TISSUE HOLDING UNIT                         LS1016   121114
217500
217500 COMBINATION HOLDING UNIT/INCUBATOR CONTAINING ELECTRONIC PLUG-IN
217500 CAPABILITY FOR MEASUREMENT DEVICES
217500
217500    TEMPERATURE RANGE ............ 41 TO 140 F    (5 TO 60 C)
217500    PO2 .......................... 160 +/-5 MM
217500    PN2 .......................... 600 +/-20 MM
217500    PCO2 ......................... 3 MM OR LESS
217500    TOTAL PRESSURE ............... 760 +/-20 MM
217500    RELATIVE HUMIDITY ............ 80 TO 100 PCT
217500
217500 COLONY GROWTH ENVIRONMENTAL CHAMBER               ST081    11112
217500
217500 HOUSING FOR COLONIES OF BACTERIA WHICH CAN BE OBSERVED DURING
217500 EXPERIMENT.  USED IN ST015, ST025 AND ST035.
217500
217500    SIZE APPROXIMATELY ........... 5 X 5 X 7 IN (13 X 13 X 18 CM)
217500
217500 INCUBATOR                                         ST083    11111
217500
217500 CONTAINER USED TO PROVIDE VARIABLE TEMPERATURE ENVIRONMENTS FOR
217500 BIOSCIENCE SPECIMEN. USED IN ST015, ST025 AND ST035.
217500
217500    SIZE APPROXIMATELY ............... 2X1.5X0.5 FT (60X51X15 CM)
217500    TEMPERATURE ...................... TO 100 F (40 C)
217500
219700 DATA BUFFERS, FORMATTERS                          MEC      21111
219700
219700 BUFFERS DATA FROM HIGH RESOLUTION WIDEBAND MULTISPECTRAL SCANNER
219700
219700    INPUT DATA RATE...............200MBPS
219700    OUTPUT DATA RATE..............100MBPS
219700    INPUT DATA DUTY CYCLE.........33%
219700
219700 STORAGE PERIPHERALS                               SP001    11111
219700
219700 THIS UNIT ACCEPTS ADDRESSED BINARY DATA FROM THE DIGITAL
219700 PROCESSOR AND TRANSLATES THIS DATA INTO EQUIVALENT ANALOG FORM.
219700
219700    MAXIMUM SIGNAL AND HOLD CHANNELS.32
219700    SIGNAL AND HOLD CHANNELS PER CARD..4
219700
219700 SIGNAL FORMATTER                                  CN070    21111
219700
219700 PROVIDES DATA FORMATTING. ACCUMULATES PRE/POST AMBLE. CLOCKS
219700 START OF EACH TEST AND DATA ACQUISITION.
219700
219700    DATA FORMAT .................. 8, 16, 32, BITS/WORD
219700    DATA RATE .................... 125000 WORDS PER SECOND
219700
219700 DATA BUFFER                                       ST010    21111
219700
219700 CAPABILITY TO ACCEPT VERY HIGH DATA RATES, PROVIDE SHORT DURATION
219700 STORAGE AND LOWER RATE DUMP CAPABILITY. USED IN ST015.
219700
219700    WORD LENGTH .................. 8 TO 32 BITS
219700    OUTPUT RATE .................. VARIABLE AT 0 TO 5 VDC
219700    STORAGE DURATION ............. INFINITE
219700
219900 PATCH PANEL, COAXIAL                              AF007    81111
219900
219900 MULTIPLE INPUT PANEL CAPABLE OF CHANNELING HIGH FREQUENCY RF
219900 ENERGY TO APPROPRIATE INSTRUMENTS WITH MINIMUM LOSS AND INTER-
219900 FERENCE.
219900
219900 COUPLER - ANTENNA (0.2 TO 2.0 MHZ)                AF909    11111
219900
219900 ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.
219900
219900    FREQUENCY BANDWIDTH .......... 0.2 TO 2.0 MHZ
219900
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219900 COUPLER - ANTENNA (2.0 TO 20.0 MHZ)                   AF910    11111
219900
219900 ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.
219900
219900    FREQUENCY BANDWIDTH ........... 2.0 TO 20.0 MHZ
219900
219900 COUPLER - ANTENNA (0.3 TO 200 KHZ)                    AF911    11111
219900
219900 ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.
219900
219900    FREQUENCY BANDWIDTH ........... 0.3 TO 200 KHZ
219900
219900 PATCH PANEL                                           AP914    51111
219900
219900 INTERFACE CONNECTIONS OF VARIOUS RF RECEIVERS WITH SELECTED TEST
219900 EQUIPMENT FOR WAVE ANALYSIS.
219900
219900 MODEM                                                 CA078    11114
219900
219900 MODULATE AND DEMODULATE VOICE OR DATA TRANSMISSIONS WITH OR WITH-
219900 OUT SPREAD SPECTRUM CAPABILITY. PROVIDES BASELINE COMMUNICATION
219900 SYSTEM, ANALOG OR DIGITAL VOICE, AND DIGITAL DATA.
219900
219900    DATA .......................... 7[illegible] BS TO 50 MBS (VARIABLE)
219900                                    MOVEABLE SS
219900    BANDWIDTH ..................... 2 MHZ
219900
219900 DEMODULATOR                                           CA079    31111
219900
219900 DEMODULATE VOICE OR DATA TRANSMISSIONS WITH OR WITHOUT SPREAD
219900 SPECTRUM CAPABILITY. PROVIDES A NUMBER OF RECEIVERS CONNECTED TO
219900 DIFFERENT ANTENNAS.
219900
219900 MODEM, WIDEBAND                                       CA080    21235
219900
219900 MODULATE AND DEMODULATE WIDEBAND FM OR DIGITAL SIGNALS. WIDEBAND
219900 FM DETECTOR WITH THRESHOLD EXTENSION. DIGITAL DEMOD WITH BIT,
219900 SYNCH, AND ERROR CORRECTION CODING. MODULATOR PORTION HAS COMPLI-
219900 MENTARY CHARACTERISTICS.
219900
222000 DEIONIZER, WATER                                      LS953    11111
222000
222000 PROVIDES A MEANS OF REMOVAL OF CATIONS AND ANIONS FROM WATER
222000 SUPPLIES REQUIRED FOR SPECIALIZED LABORATORY ANALYSIS
222000
222000    SOLIDS REMOVAL CAPABILITY.....<1 PPM
222000    IONS REMOVAL CAPABILITY.......<1 PPM
222000
225700 OPTICAL COLLIMATOR                                    CA086    11111
225700
225700 PROVIDES FOR OPTICAL ALIGNMENT OF THE LASER AND TELESCOPE. ALIGN-
225700 MENT CHECKS TO BE BOTH CONTINUOUS AND PULSED.
225700
225700 BEAM EXPANDER OPTICS                                  CA088    21111
225700
225700 PROVIDES VARIABLE BEAM DIVERGENCE CONTROL FOR LASER TRANSMITTER
225700 AND THE OPTICAL BEACON TO FACILITATE ACQUISITION.
225700
225700    TYPE .......................... AFOCAL WITH VARIABLE ELEMENT
225700                                    SEPARATION.
225700    INPUT BEAM SIZE ............... 0.25 INCH DIA
225700    EXIT BEAM SIZE ................ 1 INCH DIA
225700    INPUT BEAM CHARACTERISTICS
225700       LASER TRANSMITTER .......... TEM WAVE, GAUSSIAN DIST
225700       OPTICAL BEACON ............. 3 MRAD DIVERGENCE, GAUSSIAN
225700                                    DIST
225700    OUTPUT BEAM DIVERGENCE
225700       CO2 LASER TRANSMITTER ...... DIFF LIMIT TO 200 ARC-SEC
225700       ND:YAG LASER TRANSMITTER .. DIFF LIMIT TO 50 ARC-SEC
225700       OPTICAL BEACON ............. 2 ARC-MIN TO 1 DEGREE
225700    ADJUSTMENT RESPONSE TIME ...... 0.5 SEC MAX
225700
225700 BEAM DEFLECTOR                                        CA089    41111
225700
225700 ONE TYPE PROVIDES A VERNIER POINTING CONTROL WITH FASTER RESPONSE
225700 AND GREATER PRECISION THAN THE MAIN OPTICS GIMBALS. THE OTHER
225700 TYPE PROVIDES A SMALL OFFSET POINTING CAPABILITY BETWEEN THE
225700 TRACKER AXIS AND THE TRANSMITTER AXIS.
225700
225700    DEFLECTION CAPABILITY ......... TWO AXIS
225700    DEFLECTION RANGE .............. +/- 200 MICRORAD
225700    PRECISION ..................... +/- 0.2 MICRORAD
225700    SPECTRAL RANGE ................ ACCOMMODATE LASER TRANSMITTER,
225700                                    RECEIVER AND BEACON.
225700
227000 LASER                                                 EC013    11111
227000
227000 POLARIZED, COLLIMATED LIGHT SOURCE USED FOR PARTICLE HEATING AND
227000 MOTION CONTROL AS WELL AS TO ASSESS OPTICAL SCATTERING PROPERTIES
227000 OF ICE CRYSTALS
227000
227000 LASER SOURCE                                          SP004    11111
227000
227000 PROVIDE HEAT TRANSMITTED TO A SPECIMEN BY LASER BEAM. CONCEPT
227000 PROVIDES HEATING WITHOUT CONTAMINATING SPECIMEN. UNIT IS USED
227000 IN CONJUNCTION WITH CHEST-GENERAL PURPOSE ENCLOSURE
227000
227000    POWER...........................6KW
227000    COOLING CAPACITY................[illegible].5KW
227000    LASER TYPE......................ANY OF FOLLOWING FIVE:
227000           .........................CONTINUOUS WAVE HYDROGEN-FLUOR-
227000                                    INE CHEMICAL LASER, IR OUTPUT
227000           .........................CONTINUOUS WAVE FORCED CONVEC-
227000                                    TION CO2, IR OUTPUT
227000           .........................CONTINUOUS WAVE CO-O2-H2O-HE
227000                                    CHEMICAL LASER, IR OUTPUT
227000           .........................PULSED TEA CO2, IR OUTPUT
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227000          ........................PULSED TEA XENON, UV OUTPUT
227000
227000 LASER                                              ST118    11111
227000
227000 MODE-LOCKED LASER RANGING SYSTEM MEASURING RANGE, LINE-OF-SIGHT
227000 ANGLES, AND RANGE RATE BETWEEN ATL/SHUTTLE AND SEPARATE SPACE
227000 VEHICLES INCLUDING RANGE OF ATL TO GROUND.
227000
227000    RANGE TOLERANCE .............. +/- 1.18 IN (+/-3 CM) ATL-GND
227000    COOPERATIVE TARGET DISTANCE .. 300 NM (556 KM)
227000
227400 LASER ASSEMBLY - ND:YAG                            CA053    11111
227400
227400 PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE
227400 AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS
227400 APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH
227400 CONTROL, MODULATOR, AND COOLING SYSTEM.
227400
227400    LASER CAVITY
227400       WAVELENGTH ................ 1.06 MICRONS
227400       LASING MODE ............... FUNDAMENTAL (TEM..)
227400       OPTICAL OUTPUT POWER ...... 1 WATT AVERAGE
227400       EFFICIENCY ................ 1 PERCENT
227400    MODULATOR
227400       TYPE ...................... DIGITAL
227400       DATA RATE ................. 1 GBPS
227400       EXTINCTION RATIO .......... 20DB
227400    COOLING SYSTEM
227400       COOLING METHOD ............ CONDUCTIVE, NO LIQUIDS ALLOWED
227400       HEAT LOAD ................. 200 WATTS
227400
227400 LASER LINK, DOUBLED ND:YAG                         CA054    11111
227400
227400 PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE
227400 AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS
227400 APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH
227400 CONTROL, MODULATOR, DOUBLER, AND COOLING SYSTEM.
227400
227400    LASER CAVITY
227400       WAVELENGTH ................ 0.53 MICRONS
227400       LASING MODE ............... FUNDAMENTAL (TEM..)
227400       OPTICAL OUTPUT POWER ...... 0.1 WATTS AVERAGE
227400       EFFICIENCY ................ 0.1 PERCENT
227400    MODULATOR
227400       TYPE ...................... DIGITAL
227400       DATA RATE ................. 1 GBPS
227400       EXTINCTION RATIO .......... 20 DB
227400    COOLING SYSTEM
227400       COOLING METHOD ............ CONDUCTIVE, NO LIQUIDS ALLOWED
227400       HEAT LOAD ................. 200 WATTS
227400
227400 LASER BEACON , ND:YAG                              CA055    11111
227400
227400 SERVE AS A LIGHT SOURCE TO FACILITATE ACQUISITION AND/OR TRACKING
227400 FROM A DISTANT COMMUNICATION TERMINAL.
227400
227400    BEACON TYPE .................. Q-SWITCHED DOUBLED, MULTIMODE
227400                                   CAVITY.
227400    WAVELENGTH ................... 0.53 MICRONS (PREFERRED)
227400    REP RATE ..................... 5 PPS
227400    ENERGY/PULSE ................. 20 MJ AT 0.53 MICRONS
227400    PULSEWIDTH ................... 20 NSEC
227400    PUMP METHOD .................. FLASH PUMP
227400    CODING TECHNIQUE ............. PULSE POSITION MODULATION
227400    BEAMWIDTH .................... VARIABLE 1 DEG TO 1 ARC MINUTE
227400    LIFETIME ..................... 10 MEG FLASHES OR GREATER
227400    POWER CONSUMPTION ............ 100 WATTS
227400
227800 DYE LASER/FLASH LAMP                               SP001    31111
227800
227800 THIS UNIT WILL BE USED FOR FREE RADICAL GENERATION, SURFACE
227800 DAMAGE THRESHOLD DETERMINATION, AND HOLOGRAPHIC MICROSCOPY
227800
227800  ACCURACY:
227800   WAVELENGTH.......................0.01%
227800   VOLTAGE OF CAPACITOR BANK.......0.1%
227800   LASER AND FLASH LAMP ENERGY
227800      OUTPUT.......................1.0%
227800   SYNC. ACCURACY..................10NS
227800   COHERENCE.......................20%
227800  RANGE OF OPERATION:
227800   ENERGY INPUT....................500-5000J/PULSE (.14-1.4WH/PULSE
227800                                   ) AT LOW REPS, LARGE LAMP
227800               ....................50-500J/PULSE (.014-.14WH/PULSE)
227800                                   AT HIGH REPS, SMALL LAMP
227800   ENERGY OUTPUT...................1-30J/PULSE (3E-4 - 8E-3WH/PULSE
227800                                   ) AT LOW REPS, DYE FUND. FREQ.,
227800                                   250MJ TO 7J/PULSE (7E-5 - 2E-3
227800                                   WH/PULSE) FREQUENCY DOUBLED.
227800               ....................100MJ TO 3J/PULSE (3E-5 TO 8E-4
227800                                   WH/PULSE)AT HIGH REPS AT DYE
227800                                   FUNDAMENTAL, 25 - 750MJ(7E-6 -
227800                                   2E-4 WH) FREQUENCY DOUBLED
227800   REPETITION RATE.................LARGE LAMP - SINGLE TO 10/MIN
227800               ....................SMALL LAMP - SINGLE TO 20HZ
227800   FREQUENCY RANGE.................FUNDAMENTAL 430 - 750NM(1.7E-5
227800                                   TO 3E-5 IN.) FREQUENCY DOUBLED
227800                                   215 - 375NM (0.9E-5 TO 1.5E-5
227800                                   IN.)
227800    FLASH DURATION.................500 - 100NS
227800    HOLOCAMERA.....................35MM (1.4 IN.)
227800          .........................SINGLE FRAME TO 20FRAMES/SEC.
227800
227800 FLASH LAMP                                         SP001    31111
227800
227800 THE FLASH LAMP HAS TWO FUNCTIONAL REQUIREMENTS: (A)TO PRODUCE
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227800 FREE RADICALS, AND (B)AS A PUMP SOURCE FOR EXCITING THE DYE
227800 LASER
227800
227800     TYPE..........................MERCURY-XENON
227800     OPERATING TEMPERATURE..........68 TO 77F ( 20 TO 25C)
227800     WAVELENGTH.....................1.2E-5 TO 2.4E-5 IN. (300-600NM)
227800     ENERGY INPUT(MAX)..............1.5WH (5KJ)
227800                 (MIN)..............0.3WH (1KJ)
227800
228041 LASER ASSEMBLY - CO2                                   CA052   11111
228041
228041 PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE
228041 AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS
228041 APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH
228041 CONTROL, MODULATOR, AND COOLING SYSTEM.
228041
228041     LASER CAVITY
228041        WAVELENGTH ................. 10.6 MICRONS
228041        LASING MODE ................ FUNDAMENTAL (TEM..)
228041        OPTICAL OUTPUT POWER ....... 5 WATTS AVERAGE
228041        EFFICIENCY ................. 5 PERCENT
228041     MODULATOR
228041        TYPE ....................... DIGITAL
228041        DATA RATE .................. 200 MBPS
228041        EXTINCTION RATIO ........... 20 DB
228041     COOLING SYSTEM
228041        COOLING METHOD ............. CONDUCTIVE, NO LIQUIDS ALLOWED
228041        HEAD LOAD .................. 200 WATTS
228041
229500 DARK FIELD ILLUMINATOR                                 SF001   21111
229500
229600 LIGHTING SYSTEM - PLANT                                LS1018  21114
229600
229600 PROVISIONS FOR LIGHT PLANT GROWING AREAS.
229600
229600     TYPE LIGHT ..................... DAYLIGHT-FLUORESCENT
229600     ILLUMINATION ................... 102 FT-C (1100 LUM/M2)
229600
229600 CELLS/TISSUE HOLDING UNIT LIGHTING                     LS1017  21114
229600
229600 PROVISION FOR PROVIDING COOL DIFFUSED LIGHT
229600
229600     ILLUMINATION ................... 50 +/-10 FT-C
229600     TEMPERATURE .................... AMBIENT
229600
229600 LIGHT SOURCE                                           ST049   21111
229600
229600 PORTABLE LIGHT SOURCE USED   FOR PHOTOGRAPHING EXPERIMENT OPERA
229600 TIONS AND RESULTS.  USED IN ST015, ST025 AND ST035.
229600
229600     ILLUMINATION ................... 100 TO 1000 LUMENS
229600     DISTANCE ....................... UP TO 30 FEET
229600
234000 IMAGE DEVICE LIGHTING                                  EC009   11114
234000
234000 PROVIDES LIGHTING FOR VARIOUS OPTICAL RECORDING ACTIVITIES.
234000 CONSISTS OF CONTINUOUS LIGHTING, STROBOSCOPE AND LASER BEAM LIGHT
234000 SOURCES
234000
234000      HIGH INTENSITY LIGHT DURATION..<1SEC
234000
234000 STROBE LAMP                                            ST157   11111
234000
234000 VARIABLE DISCHARGING STROBE LIGHTS WHICH ALLOW THE STOPPING OF
234000 MOTION.
234000
234000     STROBE DISCHARGE RATE ........ 1 TO 1000 FLASHES/SEC
234000
235700 LYOPHILIZATION UNIT                                    SF001   11111
235700
235700 LYOPHILIZER                                            LS972   11111
235700
235700 PROVIDE FREEZE DRYING OF SMALL SPECIMENS
235700
235700     SAMPLE CAPACITY................20-100.IN.(160C)
235700     TEMPERATURE RANGE..............-40F TO 252F(-40 TO 122C)
235700
238500 MAGNET, SUPERCONDUCTING                                ST150   11112
238500
238500 MAGNET FOR DROP/PARTICLE POSITIONING
238500
256000 MICROPHONE                                             LS1007  11111
256000
256000 MICROPHONES USED FOR BIOLOGY, BIOMEDICINE AND MANNED SYSTEMS
256000 INTEGRATION
256000
263000 MICROSCOPE, DISSECTING                                 LS1004  11111
263000
263000 PERMIT DETAIL DISSECTING OF BIOLOGICAL SPECIMENS SUCH AS PLANTS,
263000 ANIMAL TISSUE AND ORGANS
263000
263000     STEREO EYEPIECE
263000     ADJUSTABLE BRIGHT AND DARK FIELD ILLUMINATION
263000
263100 MICROSCOPE, COMPOUND                                   LS1005  11111
263100
263100 GENERAL PURPOSE BINOCULAR MICROSCOPE FOR MICROSCOPIC STUDIES OF
263100 TISSUES
263100
263100     MAGNIFICATION.....................10X TO 100X
263100     PHOTOGRAPHIC CAPABILITY...........POLAROID FILM
263100     LIGHTING..........................DARK FIELD OR LIGHT FIELD AND
263100                                       PHASE CONTROL
263100
264650 IR MICROSCOPE                                          EC017   11111
264650
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264650 DETERMINE SURFACE TEMPERATURE OF DROPLETS AND ICE CRYSTALS
264650
264650    SENSITIVITY......................+/-0.54F(+/-0.3C) AT 5F (-15C)
264650
265000 MICROSCOPE                                          STC51   21111
265000
265000 MICROSCOPIC EXAMINATION OF AEROSOL PARTICLES IN THE VISUAL RANGE.
265000 ALSO COMPATIBLE WITH BIOLOGICAL AND METALLURGICAL EXPERIMENTS.
265000 USED ON ST01, ST02S AND STC35.
265000
265000    MAGNIFICATION RANGE .................. 5C TO 1000 X
265000    PHOTOGRAPHIC CAPABILITY .............. YES
265000
268500 MICROSCOPE                                          ECO17   11111
268500
268500 MAGNIFIED OBSERVATIONS
268500
268500    MAGNIFICATION FACTOR...........1C TO 1CCX
268500    OBSERVATION MODE...............VISUAL OR PHOTOGRAPHIC
268500
268900 MICROSCOPE (HIGH MAGNIFICATION)                     ECO17   11111
268900
268900 MAGNIFIED OBSERVATIONS
268900
268900    MAGNIFICATION FACTOR...........1CC X 10CCX
268900    OBSERVATION MODE...............TRINOCULAR(CAMERA ATTACHMENT)
268900
268900 RETROCONSTRUCTION HIGH RESOLUTION HOLOMICROSCOPE    SFCC1   3123!
268900
269000 STEREO MICROSCOPE                                   ECC17   11111
269000
269000 MAGNIFIED OBSERVATIONS
269000
269000    MAGNIFICATION FACTOR...........1C TO 1CCX
269000    OBSERVATION MODE...............VISUAL OR PHOTOGRAPHIC
269000    WORKING DISTANCE...............UP TO 4IN(1CCM)
269000
269000
274100 MICROTOME (CORE)                                    LS021   11111
274100
274100 CAPABILITY TO THINLY SLICE EXPERIMENT SPECIMEN.
274100
274100    SECTIONING ..................... 1 TC 50 MICROMETERS
274100
276000 ATTENUATOR CALIBRATOR                               CA068   41111
276000
276000 DYNAMIC RANGE ADJUSTMENT. REMOTE ELECTRICAL CONTROL, DIGITAL READ
276000 OUT OF VALUE. MANUAL OVER-RIDE.
276000
276000    IMPEDANCE ...................... 5C OHMS
276000    FREQUENCY ...................... DC TO 1.5 MHZ
276000    RANGE .......................... C TO 60 DB
276000
286000 MOTOR,ELECTRIC                                      ST151   11111
286000
286000 MOTOR FOR CHAMBER DRIVE SYSTEM
286000
297500 EXPANSION CLOUD CHAMBER                             ECC14   11135
297500
297500 CHAMBER PROVIDING SIMULATION OF LONG TERM, NATURAL CLOUD DURING
297500 AN ADIABATIC EXPANSION
297500
297500    DIMENSIONS.....................11.8IN.(3CCM)DIA. X 17.7IN
297500                                   (45CM)LONG
297500    VOLUME.........................1.12CU.FT.(31.8L)
297500    OPERATING TEMPERATURE......... -76F TO 104F (-60 TC 40C)
297500    UPPER AND LOWER ENDS TEMP
297500       DIFFERENTIAL................0 TO 18F(C TC 1CC)
297500    END TEMPERATURE TOLERANCE......+/-C.1F (+/-C.5C)
297500    OPERATING PRESSURE.............2.7 TC 14.7 PSIA(140 TC 760TORR)
297500    PRESSURE RATE OF CHANGE........19.4PSI/SEC (1000TORR/SEC)
297500    PRESSURE RATE TOLERANCE........+/-1%
297500    MAXIMUM VOLUME EXPANSION....... V/V OF C.5+/-0.1%
297500    CIRCULAR ENDS CONTAIN ELECTRICALLY CONDUCTIVE PLATES TO SERVE
297500       AS EQUIPOTENTIAL SURFACES FOR THE ELECTRIC FIELD MOTION
297500       CONTROL SYSTEM
297500
297500 CONTINUOUS FLOW DIFFUSION CLOUD CHAMBER             ECO14   11135
297500
297500 SUPERSATURATION IS CONTROLLED BY THE TEMPERATURE OF WATER
297500 COVERING THE UPPER AND LOWER SURFACES OF THE CHAMBER. IT WILL BE
297500 USED FOR CLOUD CONDENSATION NUCLEATION EXPERIMENTS
297500
297500    DIMENSIONS.....................11.8IN(3CCM) X 11.8IN(30CM) X
297500                                   2IN(5CM)
297500    VOLUME.........................C.16CU.FT.(4.5L)
297500    INNER PLATE DIMENSIONS........ 11.8IN(3CCM) X 10IN(25CM) SPACED
297500                                   C.5IN(1.3CM)APART
297500    ISOTHERMAL TEMP CONTROL........+/-C.1F(0.05C)
297500    UPPER AND LOWER SURFACE
297500       TEMPERATURE DIFFERENCE..... 0 TO 18F (0 TO 10C)
297500    SURFACE TEMP CONTROL...........+/-C.1F(C.05C)
297500    OPERATING PRESSURE.............14.3 TO 14.7PSIA(740 TC 760TORR)
297500    PRESSURE MEAS. ACCURACY........+/-C.2%
297500    MAX PRESSURE CHANGE RATE.......C.C8PSI/SEC(0.4TORR/SEC)
297500
297500 STATIC DIFFUSION ICE CLOUD CHAMBER                  ECO14   11135
297500
297500 THIS IS A NAKAYA TYPE CHAMBER WHICH UTILIZES ICE SURFACES TO
297500 PROVIDE CONTROLLED SUPERSATURATION RELATIVE TO ICE.
297500
297500    DIMENSIONS.....................15.75IN(40CM)DIA X 7.9IN(20CM)
297500                                   LONG
297500    VOLUME.........................C.444CU.FT.(4.5L)
297500    OPERATING TEMPERATURE..........-4C TO 77F(-40 TO 25C)
297500    TEMP MEAS. ACCURACY............+/-1.8F(+/-1.0C)
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297500    UPPER AND LOWER SURFACE
297500       TEMPERATURE DIFFERENCE......UP TO 36F (20C)
297500    SURFACE TEMP.MEAS.ACCURACY....+/-0.1F(+/-0.05C)
297500    OPERATING PRESSURE............1.5 TO 14.7PSIA(100 TO 760TORR)
297500    PRESSURE MEAS. ACCURACY.......+/-0.1PSI(+/-10TORR)
297500
297500 STATIC DIFFUSION LIQUID CLOUD CHAMBER                    EC014   11135
297500
297500 A TWOMEY TYPE CHAMBER USED FOR EXPERIMENTS REQUIRING ABOVE
297500 FREEZING TEMPERATURES AND SUPERSATURATION OF THE LIQUID RELATIVE
297500 TO WATER. SUPERSATURATION IS CONTROLLED BY THE TEMPERATURES OF
297500 THE WATER COVERING CHAMBER UPPER AND LOWER SURFACES.
297500
297500    DIMENSIONS......................6IN.(15 CM)DIA.X0.6IN(1.5CM)LONG
297500    VOLUME..........................0.01CU.FT.(0.27L)
297500    OPERATING TEMPERATURE........ 32F TO 68F (0 TO 30C)
297500    END SURFACE MAXIMUM
297500       TEMPERATURE DIFFERENTIAL....18F(10F)
297500    SURFACE TEMP.MEAS.ACCURACY....0.1%(0.05C)
297500    OPERATING PRESSURE............2.84 TO 14.7PSIA(140 TO 760TORR)
297500
297500 GENERAL CLOUD CHAMBER                                    EC014   11135
297500
297500 THIS CHAMBER WILL BE USED FOR MANY EXPERIMENTS THAT REQUIRE A
297500 RELATIVE HUMIDITY BELOW 100% AND MINIMUM TEMPERATURE CONTROL.
297500 PROVISIONS WILL BE MADE FOR GENERATING VARIOUS ELECTRIC FIELDS.
297500 POSITIONING DEVICES(SOUND, OPTICAL, ELECTRICAL), AND REMOTE
297500 DROPLET SIZING.
297500
297500    DIMENSIONS......................11.8IN(30CM) ALL SIDES (CUBE)
297500    VOLUME..........................0.95CU.FT.(27L)
297500    OPERATING TEMPERATURE.........50 TO 86F(10 TO 30C)
297500    OPERATING PRESSURE............2.84 TO 14.7PSIA(140 TO 760TORR)
297500    ELECTRIC FIELD PLATES LOCATED ON OPPOSITE SIDES
297500    ACCUSTIC DRIVERS LOCATED ON THREE MUTUALLY PERPENDICULAR SIDES
297500
297500 ENVIRONMENT CHAMBER                                      ST050   11135
297500
297500 PROVIDE SPECIAL CHAMBER TO MONITOR OPTICAL PROPERTIES OF AEROSOLS
297500 WITH CAPABILITY TO PERTURBATE THE ENVIRONMENT WITH IONS AND
297500 OBSERVING THE AEROSOLS THROUGH A MICROSCOPE AND PHOTOGRAPHING THE
297500 SCENE. USED IN ST01S, ST02S AND ST03S.
297500
297500 CHAMBER, CUBICAL TEST                                    ST188   11135
297500
297500 CHAMBER FOR PERFORMANCE OF SUPERFLUID HELIUM AND LIQUID DROP/
297500 PARTICLE EXPERIMENTS
297500
297500    DIMENSIONS......................1.8FT(0.55M)CUBE
297500
301000 RADIATION COUNTER - BIOCHEMICAL SAMPLE                   LS526   11111
301000
301000 FAST, ACCURATE AND EASY BIOCHEMICAL RADIATION COUNTING SYSTEM
301000 BASED ON STANDARD SIZED BIOCHEMICAL SAMPLES.
301000
301000    STANDARD PLANCHET ............ UP TO 2 IN DIA
301000    CAPACITY OF PLANCHETS ........ 120
301000
305000 NUCLEAR PARTICLE COUNTING UNIT                           SP001   11111
305000
305000 CAPABILITY TO DISCRIMINATE AND COUNT ALPHA, BETA, GAMMA, X-RAYS
305000 AND K-ELECTRONS.
305000
305000    COUNTING RATE ................ 3.5E+06 C/M
305000    RESOLUTION LOSS .............. 1 %/3E+06 C/M
305000    PLATEAU CHARACTER
305000               ALPHA ............. 900-1200 V @ 1 %/100V
305000          BETA-GAMMA ............. 1700-1900 V @ 1 %/100 V
305000    PRECISION .................... +/- 0.1 % FS
305000    TIMER ........................ 0.05 TO 2160 MINUTES
305000
305000 RADIATION DETECTOR                                       LS519   11111
305000
305000 ACCURATE MEASUREMENT OF EITHER ALPHA, BETA, GAMMA, X-RAY OR
305000 NEUTRON RADIATION AS IT IS APPLIED TO A BIOLOGICAL SPECIMEN.
305000
305000    RATE RANGES .................. 0 TO 0.1 MR/HR
305000                                   0 TO 1000 R/HR
305000    CALIBRATED READOUTS .......... COUNTS/SEC, /MIN, AND TOTAL
305000
308500 DOSIMETER, RADIATION DETECTOR                            LS510   11111
308500
308500 PORTABLE DEVICE WHICH WILL ALERT USER TO RADIATION LEVELS IN
308500 EXCESS OF A PREDETERMINED LEVEL AND TO PROVIDE A DIRECT READOUT
308500 OF THE TOTAL CUMULATIVE RADIATION DOSE.
308500
308500    RATE MEASUREMENT RANGE ....... 0 TO 0.1 MR/HR
308500                                   0 TO 50 R/HR
308500    ADJUSTABLE RADIATION ALARM ... 0.05 MR/HR TO 50 R/HR
308500    CUMULATIVE DOSAGE RANGES ..... 0 TO 200 MR
308500                                   0 TO 500 R
308500    ACCURACY (X- & GAMMA RAY) .... +/- 10 %
308500
308500 FILM BADGE                                               ST070   121111
308500
308500 MONITOR ASTRONAUT PERSONAL RADIATION DOSE, DOSE RATE AND DOSE
308500 HISTORY, USED IN ST01S, ST02S AND ST03S.
308500
308500    DOSE RATE .................... 0 - 0.1 MR/HR
308500                                   0 - 1000 R/HR
308500
308500 DOSIMETER - THERMOLUMINESCENT                            ST071   41111
308500
308500 PASSIVE DOSIMETER USING THERMOLUMINESCENCE TO MONITOR RADIATION.
308500 USED IN ST01S AND ST02S.
308500
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300900    ENERGY RANGE DOSE ............ 1 TO 10E+05 RADS
300900
314000 GENERATOR - ION                                    ST047   11113
314000
314000 IONIZE AEROSOL PARTICLES SO AS TO OBSERVE ZERO GRAVITY MOTION.
314000 USED IN ST015, ST025 AND ST035.
314000
319900 ISOTOPE SOURCE -SELF CONTAINED                     LS920   11111
319900
319900 RADIATION STRESS SOURCE USED IN CONDUCTING RED BLOOD CELL
319900 SURVIVAL STUDIES.  TYPICAL ASSORTMENT - NITROGEN 15 COMPOUNDS,
319900 RADIOLABELED SUBCELLULAR PRODUCTS (RIBOSOMES), RADIOLABELED POLY-
319900 NUCLEOTIDES OR TITRATED THYMIDINE.
319900
319900    RADIATION LEVEL .............. 1 TO 100 MICROCURIE
319900
320000 CONTROLLER, THREE-AXIS HAND                        AS008   11132
320000
320000 THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT
320000 POINTING AND INITIAL TARGET ACQUISITION.
320000
320000    CONTROLLED AXES .............. 3
320000
320000 CONTROLLER, THREE-AXIS HAND                        HE008   11132
320000
320000 THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT
320000 POINTING AND INITIAL TARGET ACQUISITION.
320000
320000    CONTROLLED AXES .............. 3
320000
320000 CONTROLLER, THREE-AXIS HAND                        SC008   11132
320000
320000 THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT
320000 POINTING AND INITIAL TARGET ACQUISITION.
320000
320000    CONTROLLED AXES .............. 3
320000
320000 THREE AXIS MANIPULATOR                             SF002   21132
320000
320000 MECHANICAL SAMPLE PLACEMENT AND RETRIEVAL          SF004   11113
320000
330000 COMPACTOR, WASTE SOLIDS                            LS945   11111
330000
330000 COMPACTS WASTE SOLIDS FOR EASY HANDLING
330000
330000    COMPACTION(MIN)...............1/4 INITIAL VOLUME
330000
330000 WASTE STORAGE SYSTEM                               LS982   11111
330000
330000 PROVIDE FOR HANDLING, STORAGE AND DISPOSAL OF SOLID AND LIQUID
330000 WASTE MATTER FROM THE EXPERIMENTS.
330000
330000    CAPACITY ..................... 5 CU FT
330000
359900 OPTICAL DETECTOR                                   EC009   11235
359900
359900 SOLID STATE DETECTOR TO OBTAIN DATA CONCERNING SCATTERING
359900 PROPERTIES OF ICE CRYSTALS AND POSSIBLY EXTREME DROPLET SIZE
359900 CHANGE DATA.
359900
359900 OPTICAL SENSORS                                    EC013   121111
359900
359900 SENSOR FOR CONTROL OF PARTICLE CHARACTERISTICS AND OPTICAL
359900 ENERGY SOURCES
359900
359900 LASER OPTICAL SCATTERING MONITOR                   SF001   21111
359900
359900 THE LASER OPTICAL SCATTERING MONITOR WILL PROVIDE A REAL TIME
359900 MEASURE OF LIGHT SCATTERING IN A SPECIMEN AT ANY DESIRED MEASUR-
359900 ING ANGLE. THIS DATA WILL PROVIDE INFORMATION ON THE SIZE, SHAPE,
359900 ORIENTATION, INDEX OF REFRACTION, CONCENTRATION AND LOCATION OF
359900 OPTICAL SCATTERING CENTERS.
359900
359900    LASER TYPE.....................LOW-POWER UV GAS DISCHARGE
359900    FILTER BANDWIDTH...............4E-5 IN.(0.1MM) AT HALF POWER
359900    SCATTERED LIGHT INTENSITY
359900        ACCURACY...................0.1%
359900    ANGULAR POSITION ACCURACY.....1 MIN (0.3MRAD)
359900
358900 OSCILLOSCOPE                                       AF015   21111
358900
358900 MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATING
358900
358900    BANDWIDTH .................... 500 MHZ
358900    CHANNELS ..................... 2
358900    DEFLECTION FACTOR ............ 2 MV
358900    PHOTOGRAPHIC CAPABILITY ...... YES
358900
358900 OSCILLOSCOPE                                       EC096   11111
358900
358900 MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATION.
358900
358900    BANDWIDTH .................... 100 MHZ
358900    CHANNELS ..................... 2
358900    SENSITIVITY .................. 10 MV/DIVISION
358900    TIME BASE .................... VARIABLE
358900    STORAGE CAPABILITY ........... NO
358900
358900 OSCILLOSCOPE                                       ST007   21111
358900
358900 MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATING IN
358900 THE L-BAND RANGE (390 TO 1550 MHZ).
358900 USED IN ST015, ST025, ST035, ST045, ST055, ST065, ST075, AND
358900 ST09.
358900
358900    BANDWIDTH .................... 390 TO 1550 MHZ
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Space Division
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358500    CHANNELS ............................ 2
358500    DEFLECTION FACTOR ............ 10 MV/DIVISION
358500    PHOTOGRAPHIC CAPABILITY ............ YES
358500
359500 OSCILLOSCOPE                                          EC017    11111
359500
359500 SUPPORT MAINTENANCE ACTIVITIES AND SPECIAL DATA ACQUISITION
359500
359500    FREQUENCY RANGE .............. DC TO 10.0 MHZ
359500    OBSERVATION MODE ............. VISUAL AND CAMERA (1 HR STORE)
359500
359500 OSCILLOSCOPE                                          SP001    11111
359500
359500 DISPLAY OF THE PRESENCE AND/OR NATURE AND FORM OF OSCILLATIONS
359500 OF IRREGULARITIES OF AN ELECTRIC CURRENT. STORAGE CAPABILITY OF
359500 A CRT DISPLAY IS DESIRED FOR PROLONGED OBSERVATIONS.
359500
359500    BANDWIDTH.....................DC TO 10MHZ
359500    SENSITIVITY...................INTERNAL: 0.20M DEFLECTION TO
359500                                  1 MHZ
359500         .........................EXTERNAL: 250MV P-P TO 15V P-P
359500    VIDEO STORAGE TIME............1 HOUR
359500
359600 OSCILLOSCOPE - PERSISTENT CRT (OCRE)                   LS976    11111
359600
359600 ELECTRONIC MONITOR AND DATA MEASUREMENT CAPABILITY OF LIFE
359600 SCIENCE EXPERIMENT EQUIPMENT WITH A SCREEN HAVING LONG TERM
359600 RETENTION.
359600
359600    BANDWIDTH ..................... DC TO 5 MHZ (MINIMUM)
359600    CHANNELS ...................... 2
359600    DEFLECTION FACTOR ............. 1 MV TO 10 V PER DIVISION
359600    PHOTOGRAPHIC CAPABILITY ....... YES
359600    PERSISTENCE ................... UP TO 6 HOURS
359600
367000 OPTICAL PARTICLE COUNTER                              EC011    11235
367000
367000 THIS DEVICE WILL BE A SIZE ANALYZER. THE ANALYZER CONSISTS OF A
367000 PHOTOMULTIPLIER, AN AMPLIFICATION STAGE AND SUPPORTING
367000 ELECTRONICS
367000
367000    SENSITIVE PARAMETER...........LIGHT SCATTERED FROM PARTICLES
367000    PARTICLE SIZE.................>0.3 MICROMETERS
367000
367000 ELECTRICAL PARTICLE COUNTER                           EC011    11135
367000
367000 THIS ANALYZER MEASURES THE SIZE DISTRIBUTION OF PARTICLES. THE
367000 PARTICLES ARE IONIZED AND THERE MOBILITY AS A FUNCTION OF
367000 ELECTRIC FIELD IS MEASURED TO GIVE AN INTEGRAL SIZE DISTRIBUTION
367000
367000    PARTICLE SIZE.................0.01 TO 1.0 MICROMETER
367000    FLOW RATE.....................1.8CFM (50LITERS/MIN)
367000    INTEGRAL DISTRIBUTION CAPABILITY.....YES
367000
367500 NUCLEI MASS MONITOR SYSTEM                            EC011    11235
367500
367500 THIS DEVICE MEASURES THE TOTAL PARTICULATE MASS PER UNIT VOLUME.
367500 THE SYSTEM USES A CRYSTAL OSCILLATOR WHICH CHANGES ITS RESONANT
367500 FREQUENCY AS PARTICLES ARE DEPOSITED ON IT.
367500
367500    PARTICLE COLLECTION...........ELECTROSTATIC PRECIPITATION
367500    PARTICLE SIZE.................0.01 TO 20 MICROMETERS
367500
374000 PH MONITOR                                            SP001    21111
374000
374000 MEASURE ACIDITY AND ALKALINITY OF SOLUTIONS. USED IN GP LAB ALSO
374000
374000    PH RANGE...................... 4.2 TO 12
374000    SELECTABLE RANGES............. ANY 2
374000                  ................ ANY 5
374000                  ................ ANY 10
374000    READING STABILITY............. 0.02 PH
374000    LIQUID TEMPERATURE RANGE...... 32 TO 212 F (0 TO 100 C)
374000
374000 PH METER                                              LS1016   11111
374000
374000 METER MEASURES HYDROGEN ION CONCENTRATION OF SOLUTIONS
374000
374000    PH RANGE......................0 - 14
374000    MEASUREMENT ACCURACY..........0.02PH
374000
376400 AUTOMATIC PHOTOGRAPHIC PROCESSOR                      SP001    11111
376400
376400 UNIT PROVIDES PROCESSED HOLOGRAMS AS PART OF THE ELECTRO-OPTICAL
376400 IMAGING SYSTEM
376400
376400    CYCLE TIME....................BETWEEN 5 TO 20 SEC
376400    PLATE HOLDER SIZE.............4 IN(10CM) X 5 IN(13CM)
376400    EFFECTIVE APERTURE AT PHOTO
376400         PLATE....................3.25 IN.(8.5CM) X 4.0 IN (10CM)
376400    DATA OUTPUT...................PROCESSED HOLOGRAMS
376400
376500 FRAME STORAGE UNIT                                    SP001    11111
376500
376500 THE FRAME STORAGE UNIT PROVIDES NONDESTRUCTIVE READOUT, ERASE,
376500 AND STORAGE ON ELECTRONIC COMMAND AND WORKS IN EITHER CONTINUOUS
376500 OR PULSED MODE. IT PROVIDES A REAL-TIME, NO PHOTOGRAPHIC
376500 PROCESSING, HIGH SPEED, AUTOMATIC LIGHT ADJUSTMENT CAMERA CAPABLE
376500 OF PROVIDING REAL-TIME MOVIES OR FROZEN STILLS
376500
384000 PLANT GROWTH AND SUPPORT CONTAINERS                   LS1019   121111
384000
384000 VARIOUS SIZE CONTAINER TO ENVIRONMENTLY HOUSE SEEDLINGS.
384000
384000    CAPACITY ...................... UP TO 20-CM PLANTS
384000
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396480 OPTISCAN-FIELD AND FIXATION POINT RECORDER          LS975   11111
396480
396480 THIS  INSTRUMENT  PERMITS  THE RECORDING OF THE VISUAL FIELD AS
396480 THE SUBJECT'S FIXATION WITHIN THE FIELD WITHOUT RESTRICTION OF
396480 HEAD MOVEMENTS
396480
396480    ACCURACY......................2DEG OF ARC
396480
399500 PLETHYSMOGRAPH, LIMB(INCLUDING COUPLER)             LS1010   11111
399500
399500 MEASURE CHANGES IN BLOOD VOLUME AND VASCULAR RESPONSES
399500
399500    MEASUREMENT RANGE..............HIGH RANGE-15 TO 500 CPPS
399500                                   LOW RANGE-1.5 TO 50 CPPS
399500
401000 IMPEDANCE PNEUMOGRAPH                                LS995   11111
401000
401000 MEASURE BREATHING CYCLE CHARACTERISTICS
401000
405400 RF POWER METER                                       CA060   11111
405400
405400 MEASURE RF POWER OF VARIOUS RF SOURCES.
405400
405400    FREQUENCY RANGES ............. 126 TO 130 MHZ
405400                                   136 TO 144 MHZ
405400                                   2025 TO 2120 MHZ
405400                                   13.4 TO 14.2 GHZ
405400                                   14.4 TO 15.35 GHZ
405400    ACCURACY ..................... 0.02 DB/10 DB
405400
405400 LASER POWER METER                                    CA050   11111
405400
405400 MEASURE OUTPUT LASER POWER.
405400
405400    WAVELENGTH ................... 0.53, 1.06 AND 10.6 MICRONS
405400    ACCURACY...................... +/- 5 PERCENT
405400    RANGE ........................ 300 KW
405400
405500 DC-DC CONVERTER(VOLTAGE CONTROLLED DC)               EC005   11111
405500
405500 CONVERTS SPACELAB POWER TO VOLTAGE USABLE BY ELECTRICAL FIELD
405500 GENERATING COMPONENTS
405500
405500    INPUT VOLTAGE..................28V DC
405500    OUTPUT VOLTAGE.................TBD
405500
405500 DC-DC CONVERTER (LOW FREQUENCY AC)                   EC005   11111
405500
405500 CONVERT POWER INTO USABLE FORM FOR ELECTRIC FIELD GENERATING
405500 CAPACITOR
405500
405500    FREQUENCY......................0 TO 100HZ
405500    WAVE SHAPE.....................SQUARE
405500    AMPLITUDE......................0 TO 3000 V/M
405500
405500 AC POWER CONTROLLER                                  EC017   11111
405500
405500 REGULATES AND CONTROLLS AC POWER
405500
405500    REGULATION RANGE...............TBD
405500
405500 DC POWER CONTROLLER                                  EC017   11111
405500
405500 REGULATES AND CONTROLS DC POWER
405500
405500    REGULATION RANGE...............TBD
405500
405500 RF VARIABLE POWER SUPPLY                             CA071   21111
405500
405500 PROVIDES SOURCE OF VARIABLE POWER.
405500
405500    OUTPUT ....................... 100 V PEAK
405500    VOLTAGE GAIN ................. 20 X
405500    DISTORTION ................... 0.1 % THD
405500    FREQUENCY RANGE .............. DC TO 30 KHZ
405500
406500 RF INDUCTION PWR COND. (MIXING & DISPERSAL)          SP002   21111
406500
406500 RF INDUCTION POWER CONDITIONER (2KHZ - 2MHZ)         SP002   21111
406500
407000 HIGH VOLTAGE POWER CONDITIONER                       SP001   11112
407000
407000 PROVIDES DC VOLTAGE TO EITHER THE STATIONARY OR CONTINUOUS FLOW
407000 ELECTROPHORETIC COLUMNS. REGULATION MUST REMAIN CONSTANT OVER
407000 A RELATIVELY LARGE CURRENT DEMAND.
407000
407000    OUTPUT VOLTAGE REGULATION......+-0.1%
407000    VOLTAGE RANGE..................25 TO 2500 VDC
407000    READOUTS.......................VOLTAGE LEVEL
407000    POWER OUTPUT TO COLUMNS........20W SUSTAINED
407000                                   200W PEAK
407000
407000 POWER CALIBRATION UNIT                               CA072   21111
407000
407000 PROVIDES KNOWN INCREMENTALLY CONTROLLABLE POWER LEVEL FOR
407000 STANDARDIZATION.
407000
407000    OUTPUT ....................... -100 TO +100 V
407000    LOAD REGULATION .............. 1 MV + 0.01 %
407000    LINE REGULATION .............. 10 MV + 0.01 %
407000
407000 LASER POWER SUPPLY                                   CA087   21111
407000
407000 CONVERTS AND REGULATES RAW SPACECRAFT POWER IN A FASHION SUITABLE
407000 FOR PUMPING A LASER. PRIME LASER POWER CONDITIONER AND DISTRIBU-
407000 TION FOR ALL LASERS.
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407000
407000    VOLTAGE OUTPUT ...............
407000    REGULATION ................... +/- 0.1 %
407000    POWER ........................ 100 WATTS MAX
407000    TRANSIENT RECOVERY ........... 0.1 SECONDS
407000
407000 POWER SUPPLY                                          ST171    21111
407000
407000 ELECTRICAL POWER REGULATION AND DISTRIBUTION AS REQUIRED AND AT
407000 VARIABLE VOLTAGE RANGES.  USED IN ST025, ST035 AND ST045.
407000
407000    VOLTAGE ............................ 0 TO 24 VDC
407000    POWER .............................. 200 WATTS
407000    SENSITIVITY ........................ 0.05 VOLT
407000
407500 ELECTRONIC DRIVER ASSEMBLY                            EC006    41114
407500
407500 THE ELECTRONIC DRIVER ASSEMBLY CONTROLS THE LIQUID DROP
407500 GENERATOR. IT CONSISTS OF A GENERATOR POWER SUPPLY, A PARTICLE
407500 CHARGER POWER SUPPLY AND A DUAL PULSE GENERATOR.
407500
407500 HIGH VOLTAGE POWER CONDITIONER (12KV)                 SP002    31111
407500
408000 LOW VOLT/HIGH AMP POWER CONDITIONER (10KW)            SP002    31111
408000
408800 PRESSURE SENSORS                                      EC002    51111
408800
408800 MEASURE PRESSURES THROUGH OUT THE SYSTEM
408800
408800    RANGES.........................2 TO 20 PSIA (100 TO 1000 TORR)
408800          .........................10 TO 50 PSI (6.9E4-34.5E4N/M2)
408800          .........................10 TO 300 PSI (34.5E4-2.1E6N/M2)
408900    ACCURACY.......................1% OF FULL SCALE
408800
409500 SUMP COMPRESSOR                                       EC004    11111
409500
409500 COMPRESS EXPENDED EXPERIMENT GAS SAMPLES INTO SUMP STORAGE TANK
409500
409500    COMPRESSION RATIO(MAX)........10 TO 1
409500
410000 RESERVOIR                                             EC001    11113
410000
410000 STORES COOLANT.
410000
410000 STORAGE TANK - EARTH SAMPLE                           EC004    11113
410000
410000 THIS TANK STORES SAMPLES OF EARTH GASSES. THE ASSEMBLY CONSISTS
410000 OF A PRESSURE VESSEL, A POSITIVE EXPULSION REGULATOR AND A
410000 BLADDER.
410000
410000    PRESSURE.......................1 ATM (760 MM HG)
410000    VOLUME.........................10 CU.FT.(0.28 CU.METERS)
410000
410000 GAS SAMPLE STORAGE TANKS                              EC004    51111
410000
410000 PRESSURE VESSELS FOR STORING EXPERIMENT GAS SAMPLES.
410000
410000    MAX PRESSURE(EST)..............300 PSI (2.1E06 (N/M2)
410000    VOLUME                         1 CU.FT. (0.028 CU. METERS)
410000
410000 SUMP STORAGE TANK                                     EC004    11111
410000
410000 STORE GAS SAMPLES AFTER EXPERIMENT EVALUATION.
410000
410000    MAX PRESSURE (EST).............150PSI(1.05E06N/M2)
410000    VOLUME.........................10 CU.FT. (0.28 CU.METERS)
410000
410000 BUFFER AND ELECTROLYTE SUPPLY TANKS                   SP001    11113
410000
410000 SPECIMEN/SAMPLE SUPPLY TANKS                          SP001    11113
410000
410000 WASTE LIQUID TANK                                     SP001    11113
410000
410000 COOLANT SUPPLY TANK                                   SP001    11113
410000
410000 VACUUM CATCH TUBE                                     SP004    11235
410000
410000 FUEL TANK                                             ST261    11135
410000
410000 STORE FUEL FOR COMBUSTION EXPERIMENT
410000
410000    VOLUME......................... 2 CU.FT. (0.055 CU.M.)
410000
410000 OXIDIZER TANK                                         ST262    11135
410000
410000 STORE OXIDIZER FOR COMBUSTION REACTION
410000
410000    VOLUME......................... 2 CU.FT. (0.55 CU.M.)
410000
410000 INERT GAS SUPPLY                                      ST263    11111
410000
410000 SUPPLY PRESSURE FOR EXPULSION OF FUEL AND OXIDIZER FROM STORAGE
410000 TANKS
410000
410000    VOLUME ........................ 0.22 CU.FT.(0.006 CU.M)
410000
410000 CONDENSATE TANKS                                      ST102    21113
410000
410000 TANKS FOR STORAGE OF CONDENSATE
410000
410000    PRESSURE....................... 20PSI (1.38X10E5 N/M**2)
410000
410000 STORAGE - GAS SOURCE                                  ST045    81111
410000
410000 GAS SOURCE STORAGE BOTTLES CAPABLE OF STORING VARIOUS GASES AT
410000 HIGH PRESSURES, SIMILAR TO STANDARD K-BOTTLES.  USED IN ST015.
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410000 ST025 AND ST035.
410000
410000    VOLUME - PHYSICAL ............. 5 CU FT EA (0.14 CU M)
410000    PRESSURE MAXIMUM .............. 1000 PSI
410000
410000 PRESSURE TANK                                         ST058   41111
410000
410000 PROVIDE PRESSURE SOURCE FOR WATER FEED SYSTEM TO STEAM GENERATOR
410000 EXPERIMENT
410000
410000    OPERATING PRESSURE............. 100 PSI(6.9X10E5 N/M**2)
410000
410000 WATER RESERVOIR WITH HEATER                           ST059   11113
410000
410000 STORE WATER FOR STEAM GENERATOR EXPERIMENT
410000
410000    OPERATING PRESSURE............. 30PSI(2.07X10E5 N/M**2)
410000
410000 TANKS - FUEL/OXIDIZER                                 ST179   41135
410000
410000 SIMILAR TYPE TANKS CAPABLE OF STORING CORROSIVE FUELS AND
410000 OXIDIZERS IN THE SORTIE LABORATORY AT LOW PRESSURES.  USED IN
410000 ST045 AND ST065.
410000
410000    SIZE APPROXIMATELY ............ 0.75 DIA X 3 FT
410000                                    (0.225 DIA X 0.9 M)
410000
414900 TEMPERATURE SENSORS                                   EC001   41111
414900
414900 MEASURE COOLANT TEMPERATURES
414900
414900    OPERATING TEMPERATURE RANGE...-76 TO 104F (-60 TO 40C)
414900    ACCURACY.......................+/-0.02F(+/-0.01C)
414900
414900 RESISTANCE THERMOMETER                                SF003   41111
414900
414900 THERMOCOUPLES                                         SF003   41111
414900
414900 INSTRUMENTATION SENSOR SYSTEM                         ST223   11114
414900
414900 SYSTEM INCLUDE TEMPERATURE, PRESSURE AND ACCELEROMETER SENSORS
414900
414900 TEMPERATURE SENSORS                                   ST260   11111
414900
414900 SENSOR TO MEASURE TEMPERATURE OF COMBUSTION PROCESS
414900
414900    TEMPERATURE RANGE(EST)........ 1000 TO 3000F
414900
415900 PUMP                                                  EC001   11111
415900
415900 PUMP COOLANT IN CPL COOLANT SUBSYSTEM
415900
415900    FLOW RATE(EST)..................4000LBS/HR (30000C/MIN)
415900    HEAD(EST).......................1 PSI (6.9E03 N/M2)
415900
415900 METERING PUMPS                                        SF001   11111
415900
415900 BUFFER AND SPECIMEN METERING PUMPS FOR CONTINUOUS FLOW
415900 ELECTROPHORETIC COLUMN
415900
415900    FLOW RATE-............  .007ML/MIN TO 3ML/MIN
415900    PRESSURE HEAD.........  4E04 - 5.8 TO 14 PSI(4E04 - 10E04N/M2)
415900    REPRODUCIBILITY.......          +-0.5%
415900
415900 PUMP                                                  ST100   11111
415900
415900 PUMP WATER TO STEAM GENERATOR
415900
415900    FLOW RATE...................... 0.1 LB/HR (0.045KG/MIN)
415900
415900 PUMP GAS, CIRCULATING                                 LS1C11  11111
415900
415900 PUMP FOR SEALED PLANT GROWTH CHAMBER
415900
417900 HIGH VACUUM PUMP                                      SF002   21111
417900
417900 UNIT IS USED IN CONCERT WITH MOLECULAR SIEVE. IT IS USED WITH
417900 THE SPACE VACUUM TO BLEED DOWN OVENS. THIS UNIT IS ALSO USED ON
417900 THE LEVITATION SUBELEMENT.
417900
417900    PRESSURE-ABSOLUTE ............. AMBIENT TO 0.1 PSIA
417900
419900 IR PYROMETER                                          SP002   21111
419900
419900 THE PYROMETER OPTICALLY SENSES THE INTENSITY OF RADIANT ENERGY
419900 EMITTED FROM THE SAMPLE SURFACE
419900
419900    TEMPERATURE RANGE ............. 104 TO 5400 F (40 TO 3000 C)
419900    SPECTRAL RESPONCE...............0.70 - 0.97 MICROMETERS
419900    CALIBRATION ACCURACY............+-1% FULL SCALE
419900    REPEATABILITY...................+-3% FULL SCALE
419900
419900 TWO - COLOR PYROMETER                                 SP002   21111
419900
419900 LASER PYROMETER                                       SP003   21235
419900
419900 PYROMETER                                             ST176   11111
419900
419900 MEASURE TEMPERATURE OF COMBUSTION PROCESS IN FLAME CHEMISTRY
419900 EXPERIMENTS.  USED IN ST045 AND ST065
419900
419900    TEMPERATURE RANGE ..................... 0 TO 3000 DEG F
419900
423000 DIGITAL TAPE RECORDER                                 SF001   11111
423000
423000 PROVIDE DATA STORAGE FOR DIGITAL PROCESS PROGRAMMER
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    CHANNELS........................15

RECORDER-TAPE                                         AS011   11111

RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND
DISPLAY CONSOLE.

    BANDWIDTH ..................... DC TO 200 KHZ
    CHANNELS ...................... 14
    TIME MARKS .................... EDGE TRACK
    RECORDED FORMAT ............... DIGITAL

RECORDER-TAPE                                         ME011   11111

RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND
DISPLAY CONSOLE.

    BANDWIDTH ..................... DC TO 200 KHZ
    CHANNELS ...................... 14
    TIME MARKS .................... EDGE TRACK
    RECORDED FORMAT ............... DIGITAL

RECORDER-TAPE                                         SC011   11111

RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND
DISPLAY CONSOLE.

    BANDWIDTH ..................... DC TO 200 KHZ
    CHANNELS ...................... 14
    TIME MARKS ...................... EDGE TRACK
    RECORDED FORMAT ............... DIGITAL

TAPE RECORDER - ANALOG                                AP814   11111

RECORD AND PLAYBACK OF ANALOG DATA IN SUPPORT OF ATMOSPHERIC AND
SPACE PLASMA PHYSICS SORTIE LABORATORY INVESTIGATIONS.

    BANDWIDTH ..................... 2 MHZ
    CHANNELS ...................... 14
    RECORDING FORMAT .............. FM

TAPE RECORDER - DIGITAL                               AP817   21111

RECORDING AND PLAYBACK OF DIGITAL DATA COMPATABLE WITH ANY ON-
BOARD COMPUTING EQUIPMENT.

    BANDWITH ...................... 2 MHZ
    CHANNELS ...................... 8
    SIGNAL ........................ 0 TO 5 VDC DIGITAL

TAPE RECORDER                                         EC010   11111

RECORD DATA ON MAGNETIC TAPE

    BIT RATE........................100B/S
    STORAGE CAPACITY................3.5E07BITS

DIGITAL TAPE RECORDER                                 EC086   11111

PROVIDES FOR RECORDING SENSOR DIGITAL OUTPUT DATA.

    TAPE SIZE ..................... 1 INCH
    TRACKS ........................ 5
    TAPE SPEED .................... VARIABLE
    DATA RATE ..................... 1.3E+06 BPS
    REEL SIZE ..................... 12 INCHES DIA

DIGITAL RECORDER                                      EC091   11111

PROVIDES FOR RECORDING DIGITAL OUTPUT DATA.

    TAPE SIZE ..................... 1 INCH
    TRACKS ........................ 5
    REEL SIZE ..................... 12 INCHES
    TAPE SPEED .................... VARIABLE
    DATA RATE...................... 80 MBPS

MAGNETIC TAPE RECORDER                                MEC     21111

ONBOARD DATA RECORDING OF SCIENTIFIC INSTRUMENT DATA

    READ IN RATE....................100MBPS
    STORAGE CAPACITY/MISSION.......3E12 BITS

TAPE INPUT UNIT                                       SF001   11111

RECIEVES,STORES,TRANSMITS DATA OF OTHER EQUIPMENT

    TAPE CAPACITY...................1200FT(360M), 0.5IN.(1.3CM) WIDE
    TAPE SPEED...................... 25,18.75 AND 12.5 IN/S
        ............................(64,48 AND 32 CM/S)
    LONG TERM VARIATION............+-1%
    DATA DENSITY....................1600 CPI (PHASE ENCODED)
           .........................200,556,800 CPI (NRZI)

MAGNETIC TAPE RECORDER                                LS950   11111

RECORD DATA

    DATA RATE ......................30K BPS
    TOTAL DATA STORED .............1E+0E05 BITS

TAPE RECORDERS (HIGH-SPEED MULTICHANNEL)              ST056   11111

MULTIPLE CHANNEL HIGH SPEED ELECTRONIC DATA RECORDING SYSTEM.
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424000 USED ON ST01S, ST02S AND ST03S.
424000
424000     BANDWITH ...................... 1 KHZ TO 2.0 MHZ
424000     CHANNELS ...................... 14
424000     SIGNAL TYPE ................... ANALOG
424000
424000 TAPE RECORDER, ANALOG                                   ST009   21111
424000
424000 RECORD VOICE, FM AND VIDEO DATA OF LANDMARK AND STAR-TRACKING
424000 FIELDS. USED IN ST02S, ST03S AND ST09S.
424000
424000     BANDWIDTH ..................... TO 2.5 MHZ
424000     RECORDING FORMAT ......................... VOICE, FM AND VIDEO
424000     CHANNELS ...................... 7
424000
424000 RECORDER, DIGITAL                                       CA905   11111
424000
424000 ACCURATE RECORDING OF RAW DIGITAL DATA
424000
424000     SIGNAL TYPE ................... 0 TO 5 VDC DIGITAL
424000     CHANNELS ...................... 9
424000     TAPE SPEED .................... VARIABLE
424000     DATA RATE ..................... 1.9E+06BPS
424000
424000 TAPE RECORDER, DIGITAL                                  ST008   21111
424000
424000 RECORD AND PLAYBACK OF DIGITAL DATA IN SUPPORT OF MICROWAVE
424000 INTERFEROMETER AND TRACKING INVESTIGATIONS.
424000 USED IN ST01S, ST02S, ST03S, ST04S, ST05S, ST06S, ST07S AND
424000 ST09S.
424000
424000     SIGNAL TYPE ................... 0 TO 5 VDC
424000     BANDWITH ...................... 100 TO 250 KHZ
424000     CHANNELS ...................... 4 (MINIMUM)
424000     DATA REQUIREMENT .............. 2 HRS (MINIMUM)
424000
424100 RECORDER, OPTICAL                                       ST273   11235
424100
424100 RECORD AND PLAYBACK DIGITALLY GENERATED DATA FROM A LASER SYSTEM.
424100 USED ON ST02S AND ST03S.
424100
424100     BANDWIDTH ..................... TO 50 MHZ
424100     SIGNAL ........................ DIGITAL
424100     CHANNELS ...................... 3
424100
424200 RECORDER, VIDEO                                         CA910   11111
424200
424200 PROVIDES FOR RECORDING VIDEO DATA.
424200
424200     CHANNELS ...................... 2
424200     BANDWIDTH ..................... 4 MHZ MINIMUM
424200     DURATION ...................... 1.5 HRS MINIMUM
424200
429000 RECORDER - VOICE (CORE)                                 LS1006  11111
429000
429000 CAPABILITY OF RECORDING ORAL COMMENTS.
429000
429000     CHANNELS ...................... 4
429000     BANDWIDTH ..................... 50 TO 20000 HZ
429000
429900 RECORDER - STRIP CHART                                  AP012   21111
429900
429900 RECORD HARD COPY DATA FROM LOW FREQUENCY ANALOG INVESTIGATIONS
429900
429900     FREQUENCY RESPONSE ............ DC TO 150 HZ
429900     CHANNELS ...................... EVENT, TIME, 2- DATA
429900     ACCURACY ...................... +/- 0.5 PCT
429900
429900 RECORDER - STRIP CHART                                  AP013   21111
429900
429900 RECORD HARD COPY DATA.
429900
429900     CHANNELS....................... 8
429900
429900 RECORDER - STRIP CHART (CORE)                           LS1013  11111
429900
429900 HARD RECORD OF APPROPRIATE LIFE SCIENCES DATA.
429900
429900     FREQUENCY RESPONSE ............ DC TO 150 HZ
429900     SENSITIVITY ................... 0.1 TO 50 MV/MM
429900     CHANNELS ...................... 8
429900     CHART SPEED ................... 1 TO 500 MM/SEC
429900     WRITING METHOD ................ THERMAL
429900
429900 VISICORDER                                              CA914   11111
429900
429900 REAL-TIME RAW DATA RECORDING.
429900
429900     BANDWIDTH ..................... DC TO 5000 HZ
429900     CHANNELS ...................... 18
429900     RECORDING FORMAT .............. CRT HARD COPY
429900
429900 RECORDER - STRIP CHART                                  ST015   11111
429900
429900 RECORD ANALOG MICROWAVE RADIOMETER DATA MONITORING SEA SURFACE
429900 TEMPERATURE AND ROUGHNESS.
429900 USED IN ST01S.
429900
429900     FREQUENCY RESPONSE ................ 150.0 HZ
429900     SENSITIVITY ................... 10 MV/DIVISION
429900     CHANNELS ...................... 2
429900     INPUTS ........................ 2
429900
430000 X-Y RECORDER                                            AP011   21111
430000
430000 REAL-TIME ACCURATE REPRODUCTION OF SPECTRAL DATA SOURCES PLOTTED
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430000 ON CARTESIAN COORDINATES.
430000
430000    CHANNELS ........................ 1
430000    ACCURACY ........................ +/- 0.2 % FS
430000
430000 X-Y PLOTTER                                              CA907    11111
430000
430000 PROVIDES REAL-TIME ACCURATE REPRODUCTION OF SPECTRAL DATA SOURCES
430000 PLOTTED ON CARTESIAN COORDINATES.
430000
430000    CHANNELS ........................ 4 PLUG INS
430000    ACCELERATION .................... 1500 IN/S/S (3800 CM/S/S)
430000    SENSITIVITY ..................... 0.5MV/IN (0.25 MV/CM)
430000
435000 DISSOLVED OXYGEN ANALYZER                                SP001    11111
435000
435000 THE UNIT WILL DETERMINE THE AMOUNT OF DISOLVED OXYGEN PRESENT IN
435000 THE ELECTROLYTE AFTER IT HAS BEEN PROCESSED THROUGH THE GAS
435000 ELIMINATION SYSTEM. IT WILL MONITOR OXYGEN DURING A REACTION
435000 EXPERIMENT  IT WILL ALSO FUNCTION AS A GASEOUS OXYGEN MONITOR
435000
435000    CONCENTRATION RANGE............ 0 TO TOTAL OXYGEN SATURATION
435000    ACCURACY....................... +-1%
435000    RESPONCE TIME.................. 50% ACTUAL IN 10SECONDS
435000    SAMPLE TEMPERATURE RANGE....... 32 TO 110F (0 TO 43C)
435000
435000 RESIDUAL GAS ANALYZER                                    SP002    21111
435000
435000 IDENTIFY TYPE AND QUANTITY OF GAS REMAINING IN A PROCESSING
435000 CHAMBER OR GENERATED DURING A PROCESS. THE ANALYZER IS ALSO USED
435000 IN THE LEVITATION SUBELEMENT. THE UNIT MUST HAVE A TUNABLE MASS
435000 UNIT SECTION FOR LEAK DETECTION, BE A QUADRUPOLE TYPE INSTRUMENT
435000 CAPABLE OF SEPARATING MASSES. THE INSTRUMENT MUST ACT AS A
435000 PARTIAL AND TOTAL PRESSURE ANALYZER AS WELL AS GAS ANALYZER.
435000
435000    MASS RANGE RESOLUTION..........        UP TO 200AMU
435000    DETAILED SPECTRAL ANAL MASS RANGES....1-50 AND 40-65AMU
435000    SCOPE SCAN SPEED...............        VARIABLE  3MS TO 300S
435000    DATA OUTPUT....................        VISUAL ANALOG
435000                                           ANALOG
435000                                           DIGITAL
435000    USEFUL PRESSURE RANGE..........1.0E-5 PSI(7.5E-2N/M2)
435000                              TO 1.0E-11 PSI (7.5E-8N/M2)
435000    MASS SEPARATION CAPABILITY.....          1AMU
435000    MIN DETECTABLE PARTIAL PRESSURE..2E-12 PSI (1.5E-8N/M2)
435000    MIN DETECTABLE TOTAL PRESSURE......1E-10 PSI (7.5E-7N/M2)
435000
435000 GAS ANALYZER, AUTOMATIC                                  LS953    11111
435000
435000 DETERMINE THE PARTIAL PRESSURES OF OXYGEN AND CARBON DIOXIDE
435000 DISSOLVED IN BLOOD SAMPLES AND TO DETERMINE THE HYDROGEN ION
435000 CONCENTRATION
435000
435000    (REQUIREMENTS UNSPECIFIED. COMMERCIAL UNIT USED AS MODEL)
435000    PH..............................6.000 TO 8.000
435000    CO2 PARTIAL PRESSURE...........0 TO 200MM HG
435000    O2 PARTIAL PRESSURE............0 TO 2000MM HG
435000    ACCURACY:
435000        PH.........................+/-0.003P
435000        CO2 PARTIAL PRESSURE.......+/-0.5PM
435000        O2 PARTIAL PRESSURE........+/-1MM HG AT 200 PO2
435000                                   +/-10MM HG AT 2000 PO2
435000
435000 GAS ANALYZER, CO2 SPECIFIC                               LS961    11111
435000
435000 THIS DEVICE IS USED TO MONITOR ATMOSPHERIC CARBON DIOXIDE LEVELS
435000
435000    PARTIAL PRESSURE RANGE.........130 - 2700PA(1-20 MM HG)
435000
438500 MICROBIOLOGICAL SAMPLE STORAGE                           ST082    21112
438500
438500 STORAGE RACK FOR SPACE-TYPE PLASTIC BAG, SWABS AND CAPSULES TO
438500 DESTROY BACTERIA IN CASE OF BREAKAGE.  USED IN ST015, ST025 AND
438500 ST035.
438500
438500    SIZE APPROXIMATELY ............ 16X13X6 IN (40X33X15 CM)
438500
459605 MASS SPECTROMETER                                        LS994    11111
459605
459605 PROVIDE ANALYSIS OF UNKNOWN IONIZED GAS BY ATOMIC MASS NUMBER.
459605
459605    MASS RANGE......................1 TO 400AMU
459605    SCANNING RANGE..................VARIABLE
459605    VARIABLE SCANNING RATE.........50 MILLISECOND TO 600 SEC/SCAN
459605    MAX OPERATING PRESSURE.........1E-4TORR
459605    SELECTABLE CENTER MASS
459605    SELECTABLE SCANNING WIDTH
459605
459605 MASS SPECTROMETER                                        LS928    11111
459605
459605 PROVIDE AN ANALYSIS OF AN UNKNOWN IONIZED GAS BY ATOMIC MASS
459605 NUMBER
459605
459605    MASS RANGE......................0 TO 80 AMU
459605
459605 MASS SPECTROMETER                                        ST163    11111
459605
459605 ANALYSIS OF GASEOUS COMBUSTION PRODUCTS FORMED IN ZERO GRAVITY
459605 VIA MASS SPECTROSCOPY.  USED IN ST045 AND ST065.
459605
459605    MASS RANGE ...................... 1 TO 1000 AMU
459605    SCANNING RATE ................... 60 MSEC TO 600 SEC
459605    SENSITIVITY ..................... 1 %
459605
459605 ELECTRON SPIN RESONANCE/MASS SPECTROMETER                ST250    11112
459605
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459605 IDENTIFY CONSTITUENTS OF COMBUSTION PRODUCTS
459605
459600 IR SPECTROMETER                                       SPG03   11111
459600
459600 INFRARED ANALYSIS OF CONSTITUENTS IN GASEOUS OR LIQUID STREAMS.
459600
459600    RANGE ........................ 10 TO 100 MICRONS
459600    RESOLUTION ................... +/- 0.5 MICRONS
459600    RESPONSE TIME ................ 2 SECONDS
459600
459600 SPECTROMETER - GAMMA RAY                              ST063   11111
459600
459600 MEASURE SPACECRAFT GAMMA RADIATION BY CRYOGENICALLY COOLED LITH-
459600 IUM DRIFTED GERMANIUM DETECTOR WITH ANTI-COINCIDENCE SHIELD. USED
459600 IN ST015 AND ST035.
459600
459600    ELECTROMAGNETIC ENERGY........  100 KEV TO 6 MEV
459600
459600 SPECTROMETER - CHARGED PARTICLE                       ST064   11111
459600
459600 THIRTY MULTI-WIRE PROPORTIONAL COUNTER WITH INTERVENING LAYERS OF
459600 TISSUE EQUIVALENT PLASTIC.  USED IN ST015 AND ST035
459600
459600    PROTON ENERGY RANGE ........... 5 TO 230 MEV
459600    DEUTERIUM ENERGY RANGE......... 10 TO 300 MEV
459600    TRITIUM ENERGY RANGE........... 15 TO 230 MEV
459600    HELIUM-3 NUCLEI ENERGY RANGE . 20 TO 400 MEV
459600    ALPHA PARTICE ENERGY RANGE ... 25 TO 450 MVE
459600
459610 SPECTROMETER - NEUTRON                                ST065   11111
459610
459610 LIQUID SCINTILLATOR WITH ANTI-COINCIDENCE SHIELD PULSE SHAPE
459610 DISCRIMINATOR.  USED ON ST015 AND ST035.
459610
459610    NEUTRON ENERGY RANGE ....      0.5 TO 15 MEV
459610
459619 UV-VIS  SPECTROMETER                                  SP001   21111
459619
459619 MEASUREMENT OF SAMPLE CONSTITUENTS   BASED ON THE UV AND VISIBLE
459619 SPECTRUM.
459619
459619    RANGE ........................ 190 TO 1000 NM
459619    WAVELENGTH/WAVENUMBER ACCURACY..+/- 0.1 NM FS
459619    RESOLUTION ................... 0.05 NM
459619    RESPONSE TIME ................ 2 SECONDS
459619    SCANNING SPEED ............... 0.02 TO 2.0 NM/SEC
459619
459620 SPECTROMETER - VOLUMETRIC                             ST089   11111
459620
459620 PROVIDE A PHOTOGRAPHIC MEANS TO MEASURE INDEPENDENT VOLUME OF
459620 CELLS AND CELL SHAPES. USED IN ST015, ST025 AND ST035.
459620
459700 LONG WAVE INFRARED SPECTROMETER                       MEC     11111
459700
459700 USED FOR IDENTIFICATION OF TYPES OF ROCKS, SOILS AND SEDIMENTS
459700
459700    SPECTRAL RANGE.................0.4 TO 2.4 MICRONS
459700                   ................0.2 TO 15.5 MICRONS
459700    RADIOMETRIC CHANNEL RANGE......10 TO 12 MICRONS
459700    INSTANTANEOUS FIELD OF VIEW...1 MILLI RADIAN DIA.
459700    POINTING ANGLE FROM NADIR
459700       (PITCH, ALONG TRACK)........+45DEG  TO -10DEG
459700    POINTING ANGLE FROM NADIR
459700       (ROLL, CROSS TRACK).........+/-20DEG
459700    POINTING ACCURACY.............0.3DEG
459700
460300 SPECTROPHOTOMETER - GENERAL ANALYZER                  LS931   11111
460300
460300 SPECTRAL ANALYSIS OF GASES AND LIQUIDS INCLUDING SOLIDS OF LIGHT
460300 SOURCES.
460300
460300    FREQUENCY .................... 250 TO 2500 NANOMETERS
460300                                   (2500 TO 25000 ANGSTROMS)
460300    ACCURACY ..................... +/- 0.4 NANOMETERS
460300
462900 ANALYZER - ATOMIC ABSORPTION SPECTROPHOTOMETER        LS903   11111
462900
462900 QUANTITATIVE DETERMINATION OF METALLIC AND SEMIMETALIC ELEMENTS
462900 IN SOLUTIONS AND INDICATING CONCENTRATION.
462900
462900    WAVELENGTH RANGE ............. 200 TO 800 MILLIMICRONS
462900    MODES OF OPERATION ........... ATOMIC ABSORPTION, FLAME
462900                                   EMISSION, UV-VISIBLE SPECTRO-
462900                                   PHOTOMETRY
462900    COUNTER ACCURACY ............. +/- 0.4 NANOMETERS
462900
464600 SPECTROPHOTOMETER - IR (CORE)                         LS022   11111
464600
464600 PERFORM SPECTROPHOTOMETER ANALYSIS OF LIFE SCIENCES SPECIMEN IN
464600 THE INFRARED RANGE .
464600
464600    SPECTRAL RANGE ............... 2.5 TO 12 MICROMETERS
464600    RESOLUTION ................... 0.1 PERCENT OF WAVELENGTH
464600    SCAN TIME .................... 5 SEC TO 50 HOUR
464600    SAMPLE TEMPERATURE ........... AMBIENT TO 482 F (250 C)
464600
470900 STERILIZER - TOOL                                     LS903   11121
470900
470900 STERILIZE MISCELLANEOUS SMALL METAL HAND TOOLS SUCH AS SCALPELS.
470900 BY MEANS OF ELECTRICAL INDUCTION HEATING.
470900
470900    CAPACITY ..................... 0.1 CU FT
470900
480000 VIDICON                                               EC012   11131
480000
480000 RECORD CHAMBER PHENOMENA
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480000
480000     RESOLUTION.....................HIGH
480000     LIGHT LEVEL....................LOW
480000     IMAGE MAGNIFICATION............YES
480000     IMAGE INTENSIFICATION..........YES
480000
480000 CCTV CAMERA                                            SP001   11131
480000
480000 HIGH RESOLUTION TELEVISION CAMERA FOR VIEWING, RECORDING OR
480000 TRANSMITTING PICTURES OF MATERIAL PROCESSING EXPERIMENTS
480000
480000     BANDWIDTH......................32MHZ
480000     VERTICAL SCAN LINES............1125 LINES
480000     HORIZONTAL RESOLUTION..........1100 LINES
480000     VERTICAL SWEEP RATE............25 OR 30 FRAMES PER SECOND
480000     SENSITIVITY....................100 IRE UNITS OUTPUT PRODUCED
480000                                    WITH 0.5 FOOTCANDLE ILLUMINATION
480000
480000 VIDEO CAMERA, B/W                                      LS939   401131
480000
480000 PROVIDE MEANS OF ACTIVITY MONITORING, EXPERIMENT DATA ACQUISITION
480000 ETC. SYSTEM WILL INTERFACE WITH A 40 INPUT VIDEO MULTIPLEXER TO
480000 PERMIT THE MONITORING OF 40 SIMILAR VIDEO CAMERAS.
480000
480000     VISUAL RESPONSE................APPROXIMATE HUMAN EYE
480000     VIDEO OUTPUT...................CONSTANT WITH LIGHT LEVEL
480000                                    CHANGES OF 10 TO 10000FT CANDLES
480000                                    1.4V P-P COMPOSITE, CONFORMS TO
480000                                    EIA RS-170 STANDARD
480000
480000 CAMERA, TELEVISION                                     CA909   11131
480000
480000 PROVIDES ASTRONAUT WITH VIEW OF EARTH SCENE.
480000
480000     VIEW ANGLE .................... 20 DEGREES
480000     RESOLUTION .................... 625 LINES
480000     SPECTRAL BANDWIDTH ............ 4 MHZ
480000     SWEEP RATE .................... 15 FRAMES PER SECOND
480000
480000 CAMERA, TV                                             ST025   31131
480000
480000 REAL-TIME VIEWING OF TARGET AREAS, LAND MARK AND STAR FIELD
480000 TRACKING, AND SENSOR BORESIGHTING.
480000 USED ON ST045, ST055 AND ST065.
480000
480000     VIEW ANGLE ......................... 8 TO 10 DEGREES
480000     RESOLUTION ......................... 1025 LINES
480000
481000 VIDEO CAMERA, COLOR                                    LS940   11111
481000
481000 PROVIDE COLOR VIDEO OBSERVATIONS OF EXPERIMENTAL ANIMALS, SETUPS,
481000 ETC. FOR STORAGE VIA VIDEO-TAPE FOR TRANSMISSION TO THE GROUND.
481000
481000     RESOLUTION (MIN)...............350 LINES
481000     LENS...........................STANDARD 16MM, C MOUNT
481000
484000 BOOM POSITION TV DISPLAY                               AF801   11111
484000
484000 DISPLAY MEDIUM RESOLUTION TELEVISION OF EXPERIMENT BOOM POSITIONS
484000 BEFORE, DURING AND AFTER EACH EXPERIMENT REPETITION.
484000
484000     RESOLUTION .............. .... 525 LINES
484000     FRAME RATE .............. ....  30 FRAMES/SEC
484000     BANDWIDTH ..................... VHF RANGE
484000
484000 EXPERIMENT TV DISPLAY                                  AF802   11111
484000
484000 DISPLAY HIGH RESOLUTION TELEVISION PICTURES OF AREAS OF INTEREST
484000 IN REAL TIME OR FROM VIDEO RECORDERS AT VARIOUS SPEEDS.
484000
484000     RESOLUTION..................... 525 LINES
484000     FRAME RATE..................... 30 FPS
484000     BANDWIDTH...................... UHF RANGE
484000
484000 TV MONITOR                                             EC012   11111
484000
484000 DISPLAY TV CAMERA OUTPUT SHOWING CHAMBER PHENOMENA
484000
484000 TV MONITOR                                             SP001   11111
484000
484000 THE MONITOR WILL DISPLAY CCTV IMAGES AS PART OF THE ELECTRO-
484000 OPTICAL IMAGING SYSTEM.
484000
484000     SCANNING FREQUENCIES...........HORIZONTAL: 15-40 KHZ
484000                  ..............VERTICAL: 15-60 FIELDS/SECOND
484000     VERTICAL SCAN LINES............1125 LINES
484000     LINEARITY......................1% PICTURE HEIGHT
484000
484000 MONITOR - TV                                           ST026   31111
484000
484000 DISPLAY HIGH RESOLUTION TELEVISION PICTURES IN REAL-TIME OR FROM
484000 VIDEO TAPE.  USED ON ST015, ST025, ST035, ST045 AND ST055.
484000
484000     RESOLUTION .................... 625 LINES
484000     FRAME RATE .................... 30 FPS
484000     SCREEN SIZE ................... 10 IN (25.4 CM)
484000
484000 MONITOR, VIDEO                                         LS1009  11111
484000
484000 MONITOR TV PICTURES OF ANIMAL AND OTHER LAB ACTIVITIES
484000
486500 CONSTANT TEMPERATURE BLOCK (CORE)                      LS1015  21111
486500
486500 HEAT SINK MAINTAINING A CONSTANT TEMPERATURE FOR TEST TUBES AND
486500 VIALS.
486500
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486900    TEMPERATURE ..................... 240+/-1.0 F (120+/-0.5 C)
486900
487000 TEMPERATURE CONTROLLER                                  LC001   11111
487000
487000 CONTROLS COOLANT TEMPERATURE TO CONTROL CHAMBER WALL TEMPS
487000
487000    TEMPERATURE RANGE..............-76 TO 104F (-60 TO 40C)
487000    ACCURACY........................+/-0.2F (0.1C)
487000
487000 TEMPERATURE MONITOR                                     ST194   11114
487000
487000 MONITORS AND CONTROLS TEST CHAMBER TEMPERATURE
487000
498200 TIMER - EVENT                                           AS006   11111
498200
498200 DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR
498200 EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE
498200 START AND STOP COMMANDS (MINUTES AND SECONDS).
498200
498200    DISPLAY ....................... 4 DIGITS
498200    DISPLAY TYPE .................. LED
498200
498200 TIMER - EVENT                                           ME006   11111
498200
498200 DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR
498200 EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE
498200 START AND STOP COMMANDS (MINUTES AND SECONDS).
498200
498200    DISPLAY ....................... 4 DIGITS
498200    DISPLAY TYPE .................. LED
498200    INTERFACE ..................... DISCRETE
498200
498200 TIMER - EVENT                                           SC006   11111
498200
498200 DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR
498200 EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE
498200 START AND STOP COMMANDS (MINUTES AND SECONDS).
498200
498200    DISPLAY ....................... 4 DIGITS
498200    DISPLAY TYPE .................. LED
498200
498200 TIMER, EVENT                                            LS1020  11111
498200
498200 GENERAL PURPOSE ELAPSED TIME DEVICE USED FOR VARIOUS PSYCHOMOTOR
498200 TESTS
498200
498300 DIGITAL CLOCK                                           SF001   11111
498300
498300 DIGITAL TIME DISPLAY. PART OF DIGITAL PROCESS PROGRAMMER ASSY
498300
498300    DISPLAY ....................... 4 DIGITS
498300    DISPLAY TYPE .................. LED
498300
498300 TIMER, PRECISION CLOCK                                  CA502   11111
498300
498300 PROVIDES PRECISE TIME REFERENCE. MEASURE TIME AT WHICH PHASE MEAS
498300 OCCURS.
498300
498300    DISPLAY ....................... 24 BIT DIGITAL CLOCK WITH 1 HR.
498300                                      TIME PERIOD
498300    DISPLAY TYPE .................. DIGITAL
498300    ACCURACY ...................... 1E-06
498300
498900 TIMER - MISSION                                         AS007   11111
498900
498900 PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-
498900 DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE,
498900 SECOND.
498900
498900    DISPLAY ....................... 7 DIGITS BCD
498900    DISPLAY TYPE .................. LED
498900
498900 TIMER - MISSION                                         ME007   11111
498900
498900 PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-
498900 DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE,
498900 SECOND.
498900
498900    DISPLAY ....................... 7 DIGITS BCD
498900    DISPLAY TYPE .................. LED
498900
498900 TIMER - MISSION                                         SC007   11111
498900
498900 PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-
498900 DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE,
498900 SECOND.
498900
498900    DISPLAY ....................... 7 DIGITS BCD
498900    DISPLAY TYPE .................. LED
498900
498900 TIME CODE GENERATOR AND DISPLAY                         AP032   11111
498900
498900 ACCURATE FREQUENCY, TIME INTERVAL AND TIME KEEPING CAPABILITIES.
498900
498900    OUTPUTS........................ 100 KHZ, 1 MHZ, 5 MHZ
498900    ACCURACY ...................... 5E-10 PARTS PER DAY
498900
498900 TIMER                                                   ST107   11111
498900
498900 TIMING AND VARIABLE PROGRAMMING CAPABILITY TO OPERATE AND CONTROL
498900 EXPERIMENT AND SUPPORTING EQUIPMENT.  USED IN ST015 AND ST035.
498900
504900 STAINING SYSTEM - BACTERIOLOGICAL                       LS924   11111
504900
504900 STAIN AND FIX BIOLOGICAL SPECIMENS FOR MICROSCOPIC EXAMINATION.
504900
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5079CO MICRODISSECTION TOOL KIT                              LS958   11111
5079CO
5079CO    STANDARD MEDICAL MICRODISSECTION KIT
5079CO
5079CO VETERNARY MEDICAL KIT (CORE)                          LS957   11111
5079CO
5079CO INCLUDES OTOSCOPE/OPTHALMOSCOPE, REFLEX HAMMER, HEMOGLOBINOMETER,
5079CO TOURNIQUET, SYRINGES, NEEDLES, SCALPELS, HEMOSTATS, TWEEZERS, AND
5079CO OTHER STANDARD ITEMS.
5079CO
5079CO HISTOLOGY KIT/SLIDE CABINET (CORE)                    LS956   11111
5079CO
5079CO STANDARD KIT CONTAINING PROBES, KNIVES, NEEDLES, SYRINGES, COVER
5079CO SLIPS, LABLES PLUS OTHER NORMALLY INCLUDED ITEMS.
5079CO
5079CO KIT, BENCH CHEM ANAL                                  LS965   11111
5079CO
5079CO KIT CONTAINS THE TOOLS AND EQUIPMENT TO MANAGE CHEMICALS AND
5079CO BIOLOGICALS DURING VARIOUS MANUAL PROCEDURES GENERALLY PERFORMED
5079CO WITHIN THE GLOVE BOX.
5079CO
5079CO    TOOLS..........................SOLID TRANSPORT TOOLS.GRAVITY
5079CO                                   INDEPENDENT PIPETTES, VIALS,
5079CO                                   BOTTLES, AND TEST TUBES.
5079CO                                   CHEMICALS, STOPPERS, FILTERS.
5079CO                                   AND SAFETY SHIELDS
5079CO
5079CO KIT, HEMATOLOGY                                       LS966   11111
5079CO
5079CO PROVIDE TOOLS FOR SAMPLING, HANDLING, TRANSFERRING AND ANALYZING
5079CO BLOOD
5079CO
5079CO    ITEMS..........................HEMATOMETER KIT: 10 LAMBDA
5079CO                                   DISPOPIPETTES: COVERSLIPS:
5079CO                                   SLIDES: WBC AND RBC DILUENT:
5079CO                                   CRITOSEAL: HEMOCRIT TUBES(MICRO,
5079CO                                   HEPARINIZED): HEMOCRIT TUBES
5079CO                                   (MICRO, PLAIN): BLOOD DILUTING
5079CO                                   PIPETTES (WBC, RBC): COMBISTIX
5079CO                                   (URINE TEST STRIPS): LUER
5079CO                                   ADAPTERS, VACUTAINER; VACUTAINER
5079CO                                   VACUTAINER-NEEDLE UNIT:
5079CO                                   VACUTAINER TUBES, ASSORTED(2ML):
5079CO                                   SYRINGE (LARGE), PEDIATRIC
5079CO                                   ALCOHOL SWABS: LANCETS: NEEDLE,
5079CO                                   25GA, 5/8IN: NEEDLE 22GA,1 1/2IN
5079CO
5079CO KIT, LINEAR MEASUREMENT                               LS967   11111
5079CO
5079CO DETERMINE SIZE, AMPLITUDE, DISTANCE, CIRCUMFERENCE,ETC
5079CO
5079CO ITEMS.............................RULERS: TAPES: LINEAR COMPARATOR:
5079CO                                   GRIDS: CALIPERS, INSIDE AND
5079CO                                   OUTSIDE: VERNIER CALIPERS:
5079CO                                   MICROMETERS, INSIDE AND OUTSIDE
5079CO
5079CO KIT, MICROBIOLOGY                                     LS968   11111
5079CO
5079CO PROVIDE TOOLS TO FACILITATE GROWING AND ANALYZING MICROBIAL
5079CO ORGANIZING
5079CO
5079CO ITEMS.............................INOCULATING LOOP: INOCULATING
5079CO                                   NEEDLE: COTTON SWABS, PACKAGES,
5079CO                                   STERILE: SYRINGE SPL, STERILE:
5079CO                                   SLIDES, MICRO: ALCOHOL: TUBES,
5079CO                                   15X??MM, STERILE, CAPPED:
5079CO                                   ZEPHIRAN, TINCTURE, 15CC:
5079CO                                   BACTICINERATOR(STERILIZING UNIT)
5079CO                                   : THIOGLYCOLLATE, TUBED: STUART
5079CO                                   TRANSPORT MEDIA, VIALS: TSA
5079CO                                   SLANTS
5079CO
5079CO KIT, ORGANISM HOLDING AND MANAGEMENT                  LS969   11111
5079CO
5079CO PROVIDE TOOLS AND DEVICES USED IN THE HOLDING AND HANDLING OF THE
5079CO ORGANISMS
5079CO
5079CO ITEMS FOR SMALL VERTEBRATES.......GLOVE POWDER: CAGE SHIELD,
5079CO                                   PLASTIC: PLASTIC LINER WITH PAD:
5079CO                                   FOOD PELLET DISPENSER: ALCOHOL
5079CO                                   SWABS: TOWELS, PAPER, DISPO.:
5079CO                                   PLASTIC BAG(FOR EXPENDIBLES):
5079CO                                   PLASTIC BAG(FOR NONEXPENDIBLES):
5079CO                                   ORGANISM TRANSFER CAPSULE:
5079CO                                   ANIMAL TAGS
5079CO    ITEMS FOR PLANTS...............WATERING DEVICE(SPRAY BOTTLE):
5079CO                                   LABELS: FERTILIZER PACKETS:
5079CO                                   STAKES(10CM)
5079CO
5079CO KIT, PLANT TOOLS                                      LS970   11111
5079CO
5079CO PROVIDE TOOLS FOR VARIOUS PLANT MANIPULATIONS
5079CO
5079CO    ITEMS..........................SCISSORS, TWEEZERS, SPATULA,
5079CO                                   APPLICATOR, SPLINTS, TAPE
5079CO                                   DISPENSER, HYPODERMIC NEEDLES,
5079CO                                   SYRINGES, FORCEPS, PLIERS,
5079CO                                   SCREWDRIVER, SCALPELS, SEALERS
5079CO
5079CO KIT, GENERAL TOOL                                     LS971   11111
5079CO
5079CO MECHANICAL AND ELECTRICAL TOOLS AND HARDWARE TO PROVIDE
5079CO CONVENTIONAL DIAGNOSTIC, MAINTENANCE, AND SERVICE FUNCTIONS.
5079CO
5079CO    TOOLS..........................HAMMER, WRENCHES, PLIERS, SCREW
5079CO                                   DRIVERS, DRILL, ADHESIVE TAPE.
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5079CO                                        WIRE CUTTERS, WIRE TIES, WIRE,
5079CO                                        LUBRICANTS, FLASHLIGHT, SCISSORS
5079CO                                        , MULTIMETER, FASTENERS, CLAMPS,
5079CO                                        LAMP
5079CO
5079CO KIT, CLEAN UP                                              LS999    11111
5079CO
5079CO GENERAL PURPOSE CLEAN UP - SPONGES AND WIPES
5079CO
5079CO KIT, MEDICAL SURGICAL                                      LS1000   11111
5079CO
5079CO FOR VARIOUS MINOR SURGICAL PROCEDURES
5079CO
5079CO KIT, PHYSIOLOGY                                            LS1001   11111
5079CO
5079CO SPONGES, SPONGE SQUEEZER, VIALS, CALORIC STIMULATOR FOR EAR
5079CO CANAL, SYRINGES, THERMOMETERS, ETC.
5079CO
5079CO KIT,TOOL - INSECT MANIPULATION                             LS1002   11111
5079CO
5079CO TOOL KIT FOR COUNTING, SORTING, EXAMINATION,ETC.
5079CO
5217CO URINE ANALYZER - AUTOMATIC (CORE)                          LS584    11111
5217CO
5217CO CAPABILITY TO AUTOMATICALLY PERFORM URINE ANALYSES.
5217CO
5249CO VACUUM/PRESSURE MEASUREMENT UNIT                           SP002    31111
5249CO
5249CO MEASURES PRESSURES IN PROCESS CHAMBERS. UNIT IS ALSO REQUIRED
5249CO FOR GENERAL PURPOSE AND LEVITATION SUBELEMENTS.
5249CO
5249CO    PRESSURE-ABSOLUTE ............ AMBIENT TO 0.01 PSIA
5249CO
5249CO
5249CO PRESSURE SENSORS                                           ST260    11111
5249CO
5249CO SENSORS TO MEASURE PRESSURE OF COMBUSTION EXPERIMENT
5249CO
5249CO    PRESSURE RANGE................ TBD
5262CO FLOW CONTROL ASSEMBLY                                      EC004    11124
5262CO
5262CO THIS ASSEMBLY CONTROLS THE FLOW OF GASSES IN THE CPL. IT IS MADE
5262CO UP OF PLUMBING COMPONENTS, SOLENOID VALVES, A FILL ASSEMBLY, A
5262CO VENT ASSEMBLY, SAFETY COMPONENTS AND A MIXING SUBASSEMBLY.
5262CO
5262CO PRESSURE MONITOR                                           ST193    11114
5262CO
5262CO MEASURES PRESSURE IN TEST CHAMBER AND DISPLAYS DIGITALLY
5262CO
5270CO SOLENOID VALVES                                            EC001   101121
5270CO
5270CO CONTROL FLUID FLOW
5270CO
5270CO REGULATING VALVE                                           EC001    21121
5270CO
5270CO ADJUST FLUID FLOW
5270CO
5270CO PRESSURE REGULATORS                                        EC002    51121
5270CO
5270CO PRESSURE REGULATING VALVE FOR GASEOUS PRESSURIZATION SUBSYSTEM
5270CO
5270CO    REGULATION RANGE...............2.7 TO 14.7 PSIA(140 TO 760TORR)
5270CO    UPSTREAM PRESSURE(EST).........20 PSI (1.4E05 N/M2)
5270CO
5270CO PRESSURE REGULATOR                                         EC002    11121
5270CO
5270CO VALVE REGULATING SUPPLY PRESSURE
5270CO
5270CO     REGULATION PRESSURE(EST)......20 PSI (1.4E04 N/M2)
5270CO     MAX UPSTREAM PRESSURE.........300  PSI (2.1 E06 N/M2)
5270CO
5270CO SOLENOID VALVES                                            EC002   111121
5270CO
5270CO GAS SHUTOFF VALVES
5270CO
5270CO VACUUM/PRESSURE REGULATOR                                  SF002    31111
5270CO
5270CO THE UNIT REGULATES THE PRESSURE IN THE PROCESSING CHAMBERS BY
5270CO ADMITTING FLUID FROM A FLUID SUPPLY CONTAINER. THIS UNIT IS ALSO
5270CO EMPLOYED ON THE GENERAL PURPOSE AND LEVITATION SUBELEMENTS
5270CO
5270CO    PRESSURE-ABSOLUTE ............ 0.1 TO 1000 PSIA
5270CO
5307CO POWER DIVIDER, WIDEBAND                                    CA906    41111
5307CO
5307CO DIVIDES ANTENNA POWER OUTPUT.
5307CO
5307CO    INPUT PORTS ................... ONE 50 OHM PORT
5307CO    OUTPUT PORTS .................. THREE 50 OHM PORTS
5307CO
5320CO DIGITAL VOLTMETER                                          SF001    11111
5320CO
5320CO VOLTMETER FOR DATA ACQUISITION AND CONTROL UNIT
5320CO
5320CO    DC VOLT RANGE.............  100MV TO  100V
5320CO    AC VOLT RANGE.............  100MV TO   10V
5320CO    RESOLUTION................   0.1% FULL SCALE
5320CO    ACCURACY..................  +-0.5%+-1 DIGIT
5320CO
5320CO VOLTOHM METER                                              LS1012   11111
5320CO
5320CO PORTABLE RELIABLE MULTI-FUNCTION METER FOR GENERAL PURPOSE EXPER-
5320CO IMENTAL WORK AND TROUBLE SHOOTING.
5320CO
5320CO    DC VOLTS ...................... 100 MV TO 10 KV
5320CO    DC CURRENT .................... 1 MA TO 10 AMPS
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532000     AC VOLTS ..................... 10 MV TO 300 VOLTS
532000     AC CURRENT ................... 1 MA TO 1 AMP
532000     OHMMETER ..................... 10 OHMS TO 10 MOHMS
532000
532000 AC/DC VOLTMETER                                    CAC01   21111
532000
532000 MEASURE THE VOLTAGE LEVEL OF VARIOUS SIGNAL SOURCES.
532000
532000     VOLTAGE RANGE ................ +/- 100 MV; 1, 10, 100, 1000 V
532000     FREQUENCY RANGE .............. 45 HZ TO 1 MHZ
532000     ACCURACY ..................... +/- 0.01 % OVERALL
532000
601002 ANNUNCIATORS-ADVISORY                              AS012   21132
601002
601002 DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL
601002 ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD
601002 EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.
601002
601002     ANNUNCIATOR-VISUAL ........... 12 IN DUAL BANKS
601002     DISPLAY TYPE ................. RED, WHITE, GREEN
601002     ANNUNCIATOR-AUDIO ............ HORN
601002
601002 ANNUNCIATORS-ADVISORY                              HE012   21132
601002
601002 DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL
601002 ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD
601002 EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.
601002
601002     ANNUNCIATOR-VISUAL ........... 12 IN DUAL BANKS
601002     DISPLAY TYPE ................. RED, WHITE, GREEN
601002     ANNUNCIATOR-AUDIO ............ HORN
601002
601002 ANNUNCIATORS-ADVISORY                              SC012   21132
601002
601002 DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL
601002 ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD
601002 EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.
601002
601002     ANNUNCIATOR-VISUAL ........... 12 IN DUAL BANKS
601002     DISPLAY TYPE ................. RED, WHITE, GREEN
601002     ANNUNCIATOR-AUDIO ............ HORN
601002
603001 ANALOG (SCR) CONTROLLER                            SF001   11111
603001
603001 SILICON CONTROL RECTIFIER EMPLOYED AS A RELAY SWITCH
603001
603001     LOGIC LEVELS, LOGICAL"0"......0 - 0.6V
603001                   LOGICAL"1"......2.0 - 5.0V
603001     RANGE OF CONTROL..............0 - 100% IN 1 CYCLE INCREMENTS
603001
603002 BATTERY CONTROL AND MONITOR                        AF827   11114
603002
603002 REMOTE SENSING PLATFORM GIMBAL CONTROL             AF833   11134
603002
603002 EUV NORMAL INCIDENCE SPECTROMETER CONTROL          AF834   11114
603002
603002 UV-VIS-NIR SCANNING SPECTROMETER CONTROL           AF835   11114
603002
603002 HIGH RESOLUTION FOURIER SWIR SPECTROMETER CONTROL  AF836   11114
603002
603002 CRYOGENIC IR FOURIER SPECTROMETER CONTROL          AF837   11114
603002
603002 IR RADIOMETER CONTROL                              AF838   11114
603002
603002 FABRY-PEROT INTERFEROMETER CONTROL                 AF839   11114
603002
603002 UV,VIS DOCUMENTATION CAMERA CONTROL                AF840   11114
603002
603002 ELECTROSTATIC ANALYZER CONTROL                     AF841   11134
603002
603002 MAGNETIC ANALYZER CONTROL                          AF842   11134
603002
603002 KEV-MEV PARTICLE DETECTOR CONTROL                  AF843   11134
603002
603002 TOTAL ENERGY DETECTOR CONTROL                      AF844   11134
603002
603002 MAIN BOOM A CONTROL                                AF917   11134
603002
603002 PLATFORM BOOM A CONTROL                            AF918   11134
603002
603002 MAIN BOOM B CONTROL                                AF919   11134
603002
603002 GIMBALLED PLATFORM CONTROLS                        AF921   11134
603002
603002 SP BOOM CONTROL                                    AF922   11134
603002
603002 BOOM A POWER SUPPLY & DATA SYS CONTROL             AF923   11134
603002
603002 BOOM B TARGET CONTROL                              AF924   11134
603002
603002 ACCEL-DECEL CONTROL                                AF925   11134
603002
603002 DISCHARGE FILAMENT HEATER CONTROL                  AF926   11134
603002
603002 DISCHARGE POTENTIAL CONTROL                        AF927   11134
603002
603002 PULSE SEQUENCE & BURST LENGTH CONTROL              AF928   11134
603002
603002 GAS SELECTION & PRESSURE CONTROL                   AF929   11134
603002
603002 NEUTRALIZER EMISSION & BIAS CONTROL                AF930   11134
603002
603002 CHARGE EXCHANGE CHANNEL ACTUATOR CONTROL           AF931   11134
603002
603002 BEAM CURRENT MONITOR                               AF932   11134
603002
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603002 ELECTRON BEAM VOLTAGE, CURRENT HEATER CONTROL        AF933   11134
603002
603002 ELECTRON BEAM BURST LENGTH & MAGNITUDE CONTROL      AF934   11134
603002
603002 ELECTRON BEAM EXPANSION LENS CONTROL                AF935   11134
603002
603002 ELECTRON BEAM CURRENT MONITOR                       AF936   11134
603002
603002 PHASE, ANGLE, CURRENT MONITOR                       AF937   11134
603002
603002 MPD ARC VOLTAGE LEVEL CONTROL                       AF938   11134
603002
603002 MPD ARC BURST CURRENT DURATION CONTROL              AF939   11134
603002
603002 MPD ARC PULSE SEQUENCE                              AF940   11134
603002
603002 MPD ARC BEAM CURRENT MONITOR                        AF941   11134
603002
603002 GAS SELECTION & PRESSURE CONTROL                    AF942   11134
603002
603002 SPHERICAL ION PROBE CONTROL                         AF943   11134
603002
603002 CYLINDRICAL ION PROBE CONTROL                       AF944   11134
603002
603002 PLANAR ELECTRON PROBE CONTROL                       AF945   11134
603002
603002 SEGMENTED PLANAR PROBE CONTROL                      AF950   11134
603002
603002 DEP. SAT. INSTRUMENT CONTROL & HOUSEKEEPING         AF959   11134
603002
603002 DEP. SAT EJECTION MECHANISM CONTROL                 AF960   11134
603002
603002 PHOTOMETER HIGH VOLTAGE SUPPLY CONTROL              AF961   11134
603002
603002 PHOTOMETER AMPLIFIERS CONTROL                       AF962   11134
603002
603002 TV SYS CONTROL - IMAGE INTENSIFIER CONTROL          AF963   11134
603002
603002 CANNISTER EJECTION CONTROL                          AF964   11134
603002
603002 PROJECTILE CAMERA CONTROL                           AF965   11134
603002
603002 CANNISTER MONITOR                                   AF966   11134
603002
603002 SHAPED CHARGE EJECTION CONTROL                      AF967   11134
603002
603002 SHAPED CHARGE MONITOR                               AF968   11134
603002
603002 BALLOON EJECTION CONTROL                            AF969   11134
603002
603002 GAS CONTROL SYSTEM                                  AF970   11134
603002
603002 MULTIFREQUENCY PROPAGATION RECEIVER/PROCESSOR       CP004   11134
603002 & ANTENNA SYSTEM CONTROL UNIT
603002
603002 IR TEMPERATURE PROFILE RADIOMETER CONTROL UNIT      CP018   11134
603002
603002 CAMERA CONTROL                                      CP020   11134
603002
603002 GIMBAL CONTROL                                      CP020   11134
603002
603002 ALIGNMENT TV CONTROL                                AF920   11134
603002
603002 CCTV CAMERA CONTROL UNIT                            SF001   11131
603002
603002 THIS UNIT WILL PERFORM THE FOLLOWING CONTROL FUNCTIONS: LENS
603002 FOCUS, LENS F STOP, CONTRAST BRIGHTNESS AND MODE. THE UNIT WILL
603002 WORK IN TWO MODES:(1)CONTINUOUS OBSERVATION MODE,WHERE ILLUMINA-
603002 TION IS CONTINUOUS, OR (2) PULSED OBSERVATION MODE USED WHEN
603002 ILLUMINATION IS PROVIDED BY A DYE LASER OR A NAKED FLASH LAMP.
603002
603002    SCANNING.......................INTERLACED 2:1, THROUGH 1125
603002                                   LINES PER FRAME, 25 OR 30 FRAMES
603002                                   PER SECOND
603002    HORIZONTAL SCAN FREQUENCY CONTROL..36 TO 750 HZ
603002    VERTICAL SCAN FREQUENCY CONTROL  50 TO 60HZ
603002
603002 LASER - POSITIONING SERVO CONTROL                   EC013   41114
603002
603002 PROVIDES FEEDBACK AND CONTROL SIGNAL TO LASER DRIVER  FOR PROPER
603002 POSITIONING AND HEATING OF PARTICULATE SPECIMENS
603002
603002 OPTICAL MONITOR CONTROL                             CP021   11134
603002
603002 CONTAMINATION MONITOR GUAGE CONTROL                 CP021   11134
603002
603002 MASS SPECTROMETER CONTROL                           DF021   11134
603002
603002 SET POINT CONTROLLER                                SF001   11111
603002
603002 ESTABLISHES CONTROLLER SET POINT.  SET POINT CAN BE VARIED
603002 FROM PRE-PROGRAMMED INPUT
603002
603002     SIGNAL INPUT.................0 - 50MV
603002    DATA OUTPUT...................1 - 50MA,  0 - 5 VDC
603002
603002 ROOM CONTROLS                                       ST012   11114
603002
603002 CONTROLS FOR MICROWAVE INTERFEROMETER ROOMS
603002
603002 OPTICAL ANTENNA SERVO ELECTRONICS                   CP066   11114
603002
603002 SUPPORT ELECTRONICS FOR OPTICAL ANTENNA
603002
603002 LASER TRANSMITTER ELECTRONICS                       CA085   11235
603002
603002 DATA FORMATTING FOR TRANSMISSION VIA LASER CARRIER
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603002
603003 SIGNAL CONDITIONING ELECTRONICS                     EC010   11111
603003
603003 ELECTRONICS SUPPORTING DATA MANAGEMENT SUBSYSTEM
603003
603003 SIGNAL CONDITIONER                                  SF001   11111
603003
603003 AMPLIFIES AND CONDITIONS LOW LEVEL ANALOG SIGNALS AS PART OF
603003 DATA ACQUISITION UNIT
603003
603003    CAPACITY.......................UP TO 33 PAIRS OF SIGNAL WIRES
603003    OUTPUT VOLTAGE.................+-10V
603003    OUTPUT CURRENT.................+- 5MA
603003
603003 SIGNAL CONDITIONER                                  LS922   11111
603003
603003 ELECTRICAL SIGNAL TRANSFORMATION BETWEEN ANY NUMBER OF TRANS-
603003 DUCERS AND MULTIPLEXER/ANALOG TO DIGITAL CONVERTER
603003
603003    COMPUTER INPUT ............... +/- 10 VOLTS
603003
603003 SWITCH/DIPLEX/PREAMP UNIT                           CN077   11134
603003
603003 FOR SWITCHING ANTENNAS FOR DIFFERENT ALTITUDES, USE OFF RFI
603003 CANCELLATION, FORMING OMNI PATTERN ETC
603003
603004 CONTROL UNIT - ANTENNA SCAN                         CNC82   11114
603004
603004 PROVIDES VARIABLE ANGULAR SWEEP PATTERNS (SPIRAL RECTANGULAR
603004 SCANS, ETC.) OF VARIABLE ANGULAR COVERAGE.
603004
603006 CIRCUIT BREAKER/DISTRIBUTOR PANEL                   AS009   11131
603006
603006 CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO
603006 THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.
603006
603006    CIRCUIT BREAKERS ............. 18
603006    POWER CAPABILITY ............. 10 AMPS
603006
603006 CIRCUIT BREAKER/DISTRIBUTOR PANEL                   HE009   11131
603006
603006 CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO
603006 THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.
603006
603006    CIRCUIT BREAKERS ............. 18
603006    POWER CAPABILITY ............. 10 AMPS
603006
603006 CIRCUIT BREAKER/DISTRIBUTOR PANEL                   SC009   11131
603006
603006 CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO
603006 THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.
603006
603006    CIRCUIT BREAKERS ............. 18 EACH
603006    POWER CAPABILITY ............. 10 AMPS
603006
603009 CALORIMETRY MODULE - PRIMATE                        LS964   11135
603009
603009 PORTABLE AND COLAPSABLE UNIT WHICH HOUSES, FEEDS, AND ANALYZES
603009 THE PRIMATE SPECIMEN WITHIN.
603009
603009    PO2 .......................... 160 +/-10 MM HG
603009    PN2 .......................... 560 +/-20 MM HG
603009    PCO2 ......................... 6 MM HG OR LESS
603009    PH2O ......................... 12 +/-3 MM HG
603009    TEMPERATURE .................. 77 +/-4 F   (25 +/-2 C)
603009
603013 CONDENSER - WATER                                   EC003   11131
603013
603013 COLLECTS WATER VAPOR BY CONDENSING WATER CONTENT OF GAS SAMPLE
603013
603013    CONDENSATION RATE(MAX).........0.2LB/HR (91CC/HR)
603013    TEMPERATURE(MIN)...............45F(7C)
603013
603013 CONDENSER                                           ST102   11131
603013
603013 DEVICE TO CONDENSE STEAM IN ZERO GRAVITY
603013
603014 CAMERA CONTROLLER                                   LS937   11114
603014
603014 DEVICE TO CONTROL THE OPERATION OF VIDEO CAMERAS THROUGHOUT THE
603014 LABORATORIES
603014
603015 VACUUM CLEANER                                      LS943   11111
603015
603015 COLLECT GENERAL LABORATORY WASTE MATERIALS, DIRT, DUST AND DEBRIS
603015
603015    VACUUM BAG VOLUME..............0.36CU.FT. (10.2LITERS)
603015
603016 CLINOSTAT                                           LS944   11111
603016
603016 MOTOR DRIVEN MOUNTING STRUCTURE TO PROVIDE CONTINUOUS ROTATION
603016 OF PLANT SAMPLES
603016
603016    ROTATION RATES.................TBD
603016    PLATFORM LIGHTING..............TBD
603016
605001 ELECTROMAGNETIC POSITIONING COILS AND DETECTOR      SF004   11115
605001
605001 PROVIDE ALTERNATING ELECTROMAGNETIC FIELD FOR CONTACTLESS
605001 POSITION CONTROL.
605001
605001    MAGNETIC PRESSURE ............ 1.4 PSI (10 KN/SQ M)
605001
605002 ELECTROSTATIC POSITIONING PROBES AND DETECTOR       SF004   11115
605002
605002 ELECTROSTATIC FIELDS USED FOR POSITIONING EXPERIMENT SPECIMEN
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605002 SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.
605002
605002    CHAMBER PRESSURE ............. > 0.14 PSI (1 KN/SQ M)
605002                                   < 2E-06 PSI (0.01 N/SQ M)
605002
605002    CONFIGURATION ................ IN APEX OF TETRAHEDRON
605002
605003 ELECTRON BEAM SOURCE                                      SPOO4   11114
605003
605003 THE ELECTRON BEAM SOURCE WILL BE USED TO HEAT SAMPLES THAT
605003 REQUIRE NON-CONTACT HEATING. THE UNIT WILL BE USED IN THE CHEST-
605003 GENERAL PURPOSE ENCLOSURE
605003
605003    DELIVERABLE POWER..............3 - 4 KW
605003    INPUT POWER....................6KW
605003    TEMPERATURE....................4500F (2500C)
605003    MAXIMUM SAMPLE SIZE............0.15 CU.IN. (2CC)
605003    OPERATING PRESSURE.............1E-10 PSI (7.5E-7N/M2)
605003
605005 ELECTRIC FIELD CONTROLLER                                 EO005   11114
605005
605005 PROVIDE CONTROL FUNCTION FOR ELECTRIC FIELD GENERATOR. CONTROLLER
605005 SUPPORT BOTH AC AND DC POWER SUPPLIES
605005
605006 ELECTROMETER                                              LS555   11111
605006
605006 MEASURE SMALL VOLTAGES AND CURRENTS FOUND IN NERVES AND MUSCLES.
605006
605006    DC VOLTAGES MEASURED...........+/-10MICROVOLTS TO +/-1VOLT
605006    DC VOLTAGES MEASURED...........+/-1 PA TO +/-3 MA
605006    DRIFT..........................+/-5V/DAY AFTER 10MIN WARMUP
605006    OUTPUT.VOLTAGE.................+/-10V
605006
606001 FLUID SUPPLY SYSTEM                                       SPOO1   11134
606001
606001 THIS UNIT CONSISTS OF THREE ELEMENTS SUPPORTING ALL MATERIAL
606001 SCIENCE AND MANUFACTURING EXPERIMENTS. IT IS PART OF THE  CORE
606001 SUPPLEMENT PRESENT ON ALL MS/MS PAYLOADS. THE THREE ELEMENTS
606001 ARE AN INERT GAS UNIT, AN OXIDIZING GAS UNIT, AND A REDUCING
606001 GAS UNIT.
606001
607001 GAS JET POSITIONING PROBES AND DETECTORS                  SPOO4   11115
607001
607001 USE OF GAS JETS TO POSITION SPECIMEN DURING EXPERIMENT PRO-
607001 CEDURES SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.
607001
607001    GAS FILTER ................... 8E-06 INCHES (0.2 MICROMETERS)
607001    GASES ........................ HELIUM, HYDROGEN, OXYGEN
607001    CONFIGURATION ................ JET PAIR IN APEX OF TETRAHEDRON
607001    GAS PRESSURE MINIMUM ......... 0.014 PSIA (100 N/SQ M)
607001
609003 INDICATORS-CAUTION AND WARNING                            AS010   11132
609003
609003 A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF
609003 SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.
609003
609003    INDICATORS ................... 40
609003               ................... MASTER ALARM MEMORY
609003               ................... POWER/TEST CONTROLS
609003
609003 INDICATORS-CAUTION AND WARNING                            HE010   11132
609003
609003 A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF
609003 SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.
609003
609003    INDICATORS ................... 40
609003               ................... MASTER ALARM MEMORY
609003               ................... POWER/TEST CONTROLS
609003
609003 INDICATORS-CAUTION AND WARNING                            SO010   11132
609003
609003 A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF
609003 SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.
609003
609003    INDICATORS ................... 40
609003               ................... MASTER ALARM MEMORY
609003               ................... POWER/TEST CONTROLS
609003
612015 LBNP - LOWER BODY NEGATIVE PRESSURE                       LS115   11131
612015
612015 MEASURE INTERNAL BODY PRESSURE DIFFERENTIAL.
612015
612015    PRESSURE DIFFERENTIAL ........ 50 MM HG BELOW CABIN AMBIENT
612015
618010 SWEPT-BAND RECEIVER AND DEMODULATOR                       CNO67   41111
618010
618010 RECEIVE SIGNALS FROM TERRESTRIAL NOISE AND TERRESTRIAL INTERFER-
618010 ENCE SOURCES AS A FUNCTION OF TIME OF DAY AND SEASON OF YEAR.
618010
618010    FREQUENCY RANGE .............. 100 TO 1000 MHZ SWEEP MODE OR
618010                                   TUNABLE
618010    RECEIVER TYPE ................ SUPERHETERODYNE, LINEAR, SWEPT
618010                                   FREQUENCY, AGC
618010    SENSITIVITY .................. -120 DBM
618010    PRE-DETECTION BW ............. ADJUSTABLE
618010    DYNAMIC RANGE ................ 60 DB INSTANTANEOUS
618010                                   120 DB TOTAL
618010    SWEEP RATE ................... TWO RECEIVER BW PER MINUTE
618010    RECEIVER NOISE FACTOR ........ 4.0 DB
618010    BANDWIDTH .................... 1 KHZ
618010
618015 RECEIVER - RF                                             ST127   11111
618015
618015 MEASURE ELECTROMAGNETIC INTERFERENCE AT ORBITAL ALTITUDES IN THE
618015 FREQUENCY SPECTRUM OF 400 MHZ TO 15 GHZ. USED ON ST025 AND ST035.
618015
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618015    OVERALL SPECTRUM ............. 400 MHZ TO 15 GHZ
618015    SPECIFIC MULTIPATH MEASURE.... 1.5 TO 1.6 GHZ
618015                                   2.025 TO 2.3 GHZ
618015                                   13.4 TO 15.35 GHZ
618015
618016 RECEIVER - BIOTELEMETRY                                LS980   11111
618016
618016 RECEPTION OF BIOTELEMETRY SIGNALS FROM DEEP BODY TEMPERATURE AND
618016 ANIMAL ACTIVITY AS WELL AS FOR ELECTROMAGNETIC FIELD MONITORING.
618016
618016    FREQUENCY RANGE .............. TO 5 MHZ
618016    SENSITIVITY .................. 0.5 MV FOR 20 DB QUIETING
618016    TUNING ....................... VARIABLE AND CRYSTAL CONTROLLED
618016
618020 RECEIVER, KU-BAND                                      CAC47   11235
618020
618020 RECEIVE KU BAND SIGNAL FOR DETAILED EVALUATION OF PERFORMANCE
618020 CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.
618020
618020    CARRIER FREQUENCY ............ 13.4 TO 14.2 GHZ
618020    SENSITIVITY .................. +/- 25 MHZ
618020    CARRIER/NOISE DENSITY RATIO .. 56 DB/HZ
618020    DATA RATE .................... 100 TO 1000 BPS
618020                                   DATA UP TO VIDEO
618020
618030 RECEIVER, L BAND                                       CAC45   21111
618030
618030 RECEIVE L BAND SIGNALS TO DEMONSTRATE THE OPERATIONAL PERFORMANCE
618030 OF TYPICAL SPACEBORNE INTERFEROMETERS FOR AIRCRAFT AND MARINE
618030 NAVIGATION/TRAFFIC CONTROL. TRACK SIGNAL PHASE.
618030
618030    CARRIER FREQUENCY ............ 1565.75 TO 1570.25 MHZ
618030    SENSITIVITY .................. -120 DBM
618030    RECEIVER TYPE ................ PHASE LOCK, SUPERHETERODYNE,
618030                                   FIXED FREQUENCY, AGC
618030    DYNAMIC RANGE ................ 40 DB INSTANTANEOUS
618030                                   100 DB TOTAL
618030    PRE-DETECTION BW ............. 5 MHZ
618030    SWEEP RATE ................... TUNE 3 PPM OF CARRIER FREQ
618030    PHASE LOCK LOOP SNR .......... 40 DB
618030    RECEIVER NOISE FIGURE ........ 5 DB
618030    PHASE LOCK LOOP BANDWIDTH .... 10 HZ
618030
618040 RECEIVER - NAVAGATION                                  CA096   11111
618040
618040 RECEIVE SIGNALS FROM DIRECT OPTICAL SENSING OF STARS TO INVESTI-
618040 GATE THE PRECISION WITH WHICH A SATELLITE CAN BE POINTED VERTIC-
618040 ALLY USING STARS AS THE SOLE INERTIAL REFERENCE.
618040
618040    CARRIER FREQUENCY ............ 400 MHZ
618040    SENSITIVITY .................. 2.0 MV FOR 10 DB S+N/N
618040    DATA RATE .................... 2000 BPS
618040
618050 RECEIVER, VHF                                          CA046   51111
618050
618050 RECEIVE VHF SIGNALS FOR DETAILED EVALUATION OF PERFORMANCE CHAR-
618050 ACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK. PROVIDES NUMBER OF
618050 RECEIVER FRONT ENDS WHICH CAN BE CONNECTED IN DIFFERENT RECEIVE
618050 CONFIGURATIONS.
618050
618050    CARRIER FREQUENCY ............ 126 TO 130 MHZ
618050    SENSITIVITY .................. +/- 25 MHZ
618050    CARRIER/NOISE DENSITY RATIO .. 53 DBW
618050    DATA RATE .................... 100 TO 1000 BPS
618050
618060 RECEIVER, S-BAND                                       CA048   11111
618060
618060 RECEIVE S BAND SIGNAL FOR DETAILED EVALUATION OF PERFORMANCE
618060 CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.
618060
618060    CARRIER FREQUENCY ............ 2025 TO 2120 MHZ
618060    SENSITIVITY .................. +/- 25 MHZ
618060    CARRIER/NOISE DENSITY RATIO .. 65 DB/HZ
618060    DATA RATE .................... 100 TO 1000 BPS
618060                                   VOICE
618060
618070 RECEIVER, LASER ELECTRONICS                            CAC49   11235
618070
618070 PERFORMS DATA DEFORMATTING FROM LASER CARRIER BEAM
618070
618080 RECEIVER, PHASE-LOCK                                   CA911   11111
618080
618080 PROVIDES FOR TRACKING SIGNAL PHASE.
618080
618080    FREQUENCY SPECTRUM ........... 1570 MHZ TUNABLE
618080    SENSITIVITY .................. 15 KHZ
618080
618090 ELECTROPHYSIOLOGY RECEIVER                             LS913   11111
618090
618090 PROVIDE SPECIAL RECEPTION OF CARDIOVASCULAR AND NEURAL ELECTRO-
618090 PHYSIOLOGICAL EVENTS VIA BIOTELEMETRY SYSTEMS
618090
618090    SIGNAL TYPES RECEIVED..........ELECTROENCEPHALOGRAP
618090                         ..........ELECTROCARDIOGRAP
618090                         ..........VECTOCARDIOGRAPHY
618090                         ..........BALISTOCARDIOGRAPHY
618090                         ..........IMPEDANCE CARDIOGRAPHY
618090                         ..........PHONOCARDIOGRAPHY
618090
618090 BIOTELEMETRY RECEIVER - COMPACT CAGE MODULE            LS921   121113
618090
618090 MICROBACKPACKS FOR SMALL VERTEBRATE ACQUIRING AND TRANSMITTING
618090 BIO DATA.
618090
618100 NOISE FIGURE TEST SET                                  CA057   11111
618100
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Space Division
Rockwell International

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618100 MEASURE SYSTEM NOISE FIGURE.
618100
618100    NOISE FIGURE RANGE ............ 10 TO 15 DB
618100    ACCURACY ...................... +/- 0.5 DB, 0 - 30 DB
618100    INPUT FREQUENCY ............... 100 TO 1000 MHZ
618100    BANDWIDTH ..................... 1 MHZ
618100
619011 RADIATION SOURCE STORAGE                              LS979   11112
619011
619011 STORAGE FACILITY FOR RADIOACTIVE MATERIAL.
619011
619011    VOLUME APPROXIMATELY .......... 1 CU FT
619011    RADIATION PROTECTION LIMIT .... UP TO 500 MICROCURIES
619011
620001 TRACKING ANTENNA SERVO ELECTRONICS                    CPC44   11114
620001
620001 ELECTRONICS FOR ANTENNA POSITIONING AND CONTROL
620001
620001    TYPE .......................... TYPE II SERVO LOOP
620001    GAIN CONSTANT ................. 3.5E4 PER SEC SQUARED
620001    BANDWIDTH ..................... 100 HZ
620001
620002 TRACKER ELECTRONICS - FINE                            CN073   21114
620002
620002 PROVIDES ACCURATE TRACKING OF AN OPTICAL BEACON. PROVIDES CONTROL
620002 SIGNALS TO THE TELESCOPE GIMBALS AND VERNIER BEAM DEFLECTOR.
620002
620002    TYPE .......................... IMAGE DISSECTOR TRACKER
620002    FOV ........................... +/- 300 MICRORAD
620002    ACCURACY ...................... 0.5 MICRORAD
620002    SENSITIVITY ................... TO 1.06 MICRONS OR 10.6 MICRONS
620002
620003 COARSE TRACKER                                        CN084   11114
620003
620003 PROVIDES INITIAL GROUND BEACON ACQUISITION AND COARSE TRACKING.
620003
620003    DYNAMIC (SEARCH) FOV .......... 1 DEG BY 1 DEG
620003    ACCURACY (1 SIGMA) ............ +/- 200 MICRORAD
620003    TRACKING BANDWIDTH ............ 1 HZ
620003    SEARCH TIME ................... 10 SEC MAX
620003    SENSITIVITY ................... TO .53 MICRONS
620003    FALSE TARGET REJECTION ........ MUST REJECT MOON, PLANETS,
620003                                    STARS, AND SUNLIT CLOUDS.
620003
620020 TRANSMITTER - 2.0 TO 20.0 MHZ                         AF907   11111
620020
620020 VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.
620020
620020    FREQUENCY BANDWIDTH ........... 2.0 TO 20.0 MHZ
620020    TRANSMITTER POWER ............. 10 KW
620020
620021 TRANSMITTER - 0.2 TO 2.0 MHZ                          AF901   11111
620021
620021 VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.
620021
620021    FREQUENCY BANDWIDTH ........... 0.2 TO 2.0 MHZ
620021    TRANSMITTER POWER ............. 10 KW
620021
620022 ELECTROSTATIC WAVE TRANSMITTER                        AF904   11134
620022
620025 TRANSMITTER, KU BAND                                  CN051   11235
620025
620025 PROVIDE KU BAND SIGNAL FOR EVALUATION OF PERFORMANCE CHARACTER-
620025 ISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.
620025
620025    CARRIER FREQUENCY ............. 14.4 TO 15.35 GHZ
620025    STABILITY ..................... +/- 25 MHZ
620025    TRANSMITTER POWER ............. 100 WATTS
620025    EFFECTIVE RADIATED POWER ...... 33 DBW
620025    DATA RATE ..................... 1.0 MBS
620025                                    VIDEO
620025    DUTY CYCLE .................... CONTINUOUS
620025    SIGNAL BANDWIDTH .............. 900 MHZ
620025
620030 TRANSMITTER, VHF                                      CN050   11111
620030
620030 PROVIDES MEDIUM POWER OUTPUT FOR TRANSMISSION TO TDRS FOR EVAL-
620030 UATION OF PERFORMANCE CHARACTERISTICS.
620030
620030    CARRIER FREQUENCY ............. 136 TO 144 MHZ
620030    STABILITY ..................... +/- 20 KHZ
620030    OUTPUT POWER .................. 10 WATTS MAX
620030    DATA RATE ..................... 100 TO 10,000 BPS
620030    SIGNAL BANDWIDTH .............. 0.1 MHZ
620030    DUTY CYCLE .................... CONTINUOUS
620030
620050 TRANSMITTER - 0.3 TO 200 MHZ                          AF903   11111
620050
620050 VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.
620050
620050    FREQUENCY BANDWIDTH ........... 0.3 TO 200.0 MHZ
620050    TRANSMITTER POWER ............. 1.0 KW
620050
620060 ELECTROPHYSIOLOGY BACKPACK                            LS912   11235
620060
620060 BACKPACK CONTAINS THE NECESSARY ELECTRONICS FOR SENSING AND
620060 TRANSMITTING MAN'S PHYSIOLOGICAL DATA SUCH AS ECG, EEG, EMG,
62?0?0 EOG, ETC. INCLUDES SENSORS, SIGNAL CONDITIONERS, MULTIPLEXERS,
620060 A/D CONVERTERS AND TRANSMITTERS
620060
620070 LIDAR TRANSMITTER                                     EC08P   11112
620070
620070 PROVIDES SIGNAL SOURCE TO MEASURE CLOUD HEIGHTS AND AEROSOL DIS-
620070 TRIBUTION.
620070
620070    WAVE LENGTH ................... 6328 ANGSTROMS
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620070    ILLUMINATION MODES ............ RUBY, DOUBLED RUBY, DYE,
620070                                    DOUBLED DYE
620070
622010 VIEWER - WIDE ANGLE                                    MEC      11235
622010
622010 USED FOR LARGE AREA VIEWING AND ORIENTATION. INSTRUMENT SIMILAR
622010 TO THE WILD NF2 NAVIGATION SIGHT USED WITH THE WILD-HEERBRUGG
622010 RC-10 METRIC CAMERA
622010
622010    INSTANTANEOUS FIELD OF VIEW...110DEG X 110DEG
622010                              ...55DEG X 55DEG
622010                              ...20DEG X 20DEG
622010    FIELD OF VIEW.................360DEG IN AZIMUTH
622010    POINTING ANGLE FROM NADIR
622010       (PITCH, ALONG-TRACK).......0 TO 60DEG
622010    TOTAL ANGULAR COVERAGE (CROSS-
622010       TRACK) FROM NADIR (IFOV/2+
622010       POINTING ANGLE)............+/-60DEG
622010    POINTING ACCURACY (1-SIGMA)...2DEG
622010
623010 LIDAR AND GIMBAL PLATFORM MONITOR                      AF045    11134
623010
624010 MULTISPECTRAL SCANNER ELECTRONICS PACKAGE              CF006    11134
624010
625010 ISOELECTRIC FOCUSING UNIT                              SP001    11114
625010
626010 MINIMUM G WITH RF HEATING                              SP004    11235
626010
627010 FEED AND CRYSTAL HOLDER                                SP002    21113
627010
627020 PIEZOELECTRIC DRIVE                                    SP002    21114
627020
628010 ELECTROMAGNETIC MIXING AND DISPERSAL UNIT              SP002    21235
628010
628020 MECHANICAL MIXING AND DISPERSAL UNIT                   SP002    11235
628020
629010 INERTIAL INJECTOR                                      SP004    11235
629010
629020 LIQUID SYRINGE DISPENSER                               SP004    21113
629020
630010 SOLID SAMPLE STORAGE                                   SP004    11112
630010
631001 CRITICAL STATE TEST CELL                               ST207    11235
631001
631001 TEST CELL TO TEST CRITICAL POINT PHENOMENA. TEST CELL INCLUDES
631001 A THERMAL SHIELD, HEAT EXCHANGER, MICROMETER, CHAMBER, SUPPORT
631001 ELECTRONICS AND   PRESSURE TRANSDUCERS
631001
631002 POOL BOILING TEST CHAMBER                              ST218    21235
631002
631002 CHAMBER TO EVALUATE POOL BOILING PHENOMENA IN ZERO GRAVITY
631002
631003 CRYSTALIZER SAMPLE CHAMBER                             ST229    11135
631003
631003 CHAMBER FOR GROWING CRYSTALS IN ZERO G
631003
631004 SCHLIEREN TYPE OPTICS SYSTEM                           ST227    11135
631004
631004 OPTICS SYSTEM EMPLOYING SCHLIEREN METHOD TO EXAMINE THE STRUCTURE
631004 OF CRYSTALS
631004
631005 HOLOGRAPHIC INTERFEROMETER                             ST231    11235
631005
631005 DEVICE TO EXAMINE STRUCTURE OF GROWING CRYSTALS
631005
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ORIGINAL PAGE IS
OF POOR QUALITY

APPENDIX C

COMMERCIAL EQUIPMENT SHOPPING LIST

ASTRONOMY

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104180 DISPLAY CRT (CONTROL/DISPLAY CONSOLE)                  AS001   21111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND
104180 STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180    SCREEN SIZE ................... 14 IN (0.355 M)
104180
    RESEARCH INC                  #3300            $1580
        FORMAT.........................24 LINESX72 OR 80 CHARACTERS
             ..........................24 LINESX40 CHARACTERS
             ......... ............... 12 LINESX72 OR 80 CHARACTERS
        REFRESH RATE...................60 HZ
        TRANSFER RATE..................110 TO 2400 BAUD
        CHARACTER FORM.................5X7 DOT MATRIX
        DIMENSIONS.....................15-1/2WX13-1/2HX23-1/2D INCH
        WEIGHT.........................39LB (17.7KG)

    HEWLETT PACKARD               #2600A           $3580         111

    RESEARCH INC                  #812-3301        $1555         111
        SCREEN FORMAT ................... 12 LINES X 72 OR 80 CHARACTERS,
                                          24 LINES X 40 CHARACTERS
        CHARACTER FORMAT ................ 5 X 7 DOT MATRIX
        TRANSFER RATE ................... 110 TO 2400 BAUD, 10 OR 11 BIT
                                          CHARACTERS
        MODES ........................... HALF OR FULL DUPLEX-SWITCHABLE
                                          LOCAL OR REMOTE

    RESEARCH INC                  #DPS-812         $21,700       111
        COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
        DEC-PDP8-F MINI-COMPUTER, #3301 OPERATIONS CONTROL CONSOLE,
        PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
        CHANNELS ....................... 32
        MEMORY SIZE .................... 8K WORDS

    TEKTRONIX INC                 #4002A/021-0033-00/ $10975     111
                                   021-00XX-00/4901/
                                   4551
        ALPHANUMERIC FORMAT ............ 39 LINES-85 NORMAL/ITALIC CHAR,
                                         1 LINE- 84 CHAR IN SCRATCH AREA
        CHARACTER SET .................. 96 UPPER/LOWER CHAR (ASCII)
        CHARACTER SIZE ................. 70 X 90 MILS
        CHARACTER GENERATION ........... 7 X 5 DOT MATRIX
        CURSOR ......................... PULSATING 7 X 9 MATRIX
        GRAPHIC INPUT MODE ............. 1024(X) X 1024(Y) ADDRESSABLE,
                                         1024(X) X 761(Y) VIEWABLE PTS;
                                         JOYSTICK CONTROLLED, CROSS-HAIR
                                         CURSOR.
        DISPLAY MEDIUM ............ 11 IN DIA CRT
        DISPLAY AREA .............. 8.3IN.HOR.X6.1IN.VERT.
        ACCUMULATORS .............. 4
        CYCLE TIME ................ 300 NANOSEC
        CORE MEMORY ............... 32 K

    BUNKER-RAMO CORP              #2217-12CRT                    111
        CHARACTER CAPACITY (MAX) ....... 960
        CHARACTERS/LINE (MAX) .......... 80
        LINES/DISPLAY (MAX) ............ 24
        CHARACTERS REPERTOIRE .......... 62 OR 92
        VIEWING AREA ................... 8.75 X 6.25
        REFRESH AREA ................... 54 FRAMES/SEC

104020 SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE)      AS002   11111
104020
104020 PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT
104020
104020    CHANNELS ...................... 2
104020    FORMAT ........................ VIDEO AND DATA
104020    VIDEO INPUT PRESENTATION ...... RASTER SCAN
104020    SYMBOL WRITING TECHNIQUE ...... STROKE
104020    INTERFACE DESCRIPTION ......... DIGITAL-12-BIT DATAWORD
104020
    TEKTRONIC                     #4002A/021-00XX-00   $9550     111
        DISPLAY MEDIUM .................. 11 INCH DIRECT-VIEW, BISTABLE
                                          STORAGE CRT WITH REFRESHED
                                          SCRATCH PAD AREA
        DISPLAY AREA .................... 8.3 INCHES HORIZONTAL X 6.1
                                          INCHES VERTICAL
        ALPHANUMERIC MODE
            FORMAT ...................... 39 LINES OF 85 NORMAL OR ITALIC
                                          CHARACTERS IN MAIN AREA, ONE
                                          LINE OF 84 CHARACTERS IN
            CHARACTER SET ............... 96 UPPER AND LOWER CASE PRINT-
                                          ING CHARACTERS (ASCII CODE)
            CHARACTER SIZE .............. 70X90 MILS (CAN BE DOUBLE SIZE)
            CHARACTER GENERATION ........ 7X9 DOT MATRIX
            CURSOR ...................... PULSATING 7X9 MATRIX
        GRAPHIC MODES ................... LINEAR INTERPOLATE, INCREMENTAL
                                          PLOT, POINT PLOT, 1024X1024
                                          ADDRESSABLE POINTS, 1024X761
                                          VIEWABLE POINTS
        GRAPHIC INPUT MODE .............. 1024 (X), 761 (Y) POINTS, JOY-
                                          STICK CONTROLLED, CROSS-HAIR
                                          CURSOR
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101340 FUNCTION KEYBOARD                                        AS003   11111
101340
101340 ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO
101340 DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY.
101340 FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.
101340
101340    KEYBOARD ........................ TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ......... DIGITAL-32-BIT WORD
101340
    BUNKER-RAMO CORP              #2200                                 111
       KEYS ............................. TYPEWRITER SET STD
       PROGRAM ASSIST KEYS ............. 16
       INTERFACE ........................ CRT
       EDITING KEYS ..................... FULL SET

101340 ALPHANUMERIC KEYBOARD                                    AS004   11111
101340
101340 ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ........................ TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ......... DIGITAL-32-BIT WORD
101340
    BUNKER-RAMO CORP              #2200           $440                  111
       KEYS ............................. TYPEWRITER SET STD
       PROGRAM ASSIST KEYS ............. 16
       INTERFACE ........................ CRT
       EDITING KEYS ..................... FULL SET
164000 MICROFILM VIEWER                                         AS005   11111
164000
164000 PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-
164000 SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES,
164000 SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.
164000 -
164000    FILM FORMAT ..................... 16 MM DUAL TRACK
164000    FILM LOADING .................... CASETTE
164000    FILM SLEWING .................... MANUAL AND COMPUTER SELECT
164000    INTERFACE DESCRIPTION ......... DIGITAL 13-BIT BINARY
164000
    CALMA CO.                     #3C3M           $28000                111
       FUNCTION ......................... OFF LINE DIGITIZING SYSTEM
                                          WITH FILM PROJECTION.
                                          PROVIDES CAPABILITY OF
                                          DIGITIZING FILM DATA

498200 TIMER - EVENT                                            AS006   11111
498200
498200 DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR
498200 EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE
498200 START AND STOP COMMANDS (MINUTES AND SECONDS).
498200
498200    DISPLAY ......................... 4 DIGITS
498200    DISPLAY TYPE .................... LED
498200
    ROHDE AND SCHWARZ             #CAD (100.6597.91)/ $5440             111
       DISPLAY .......................... 6 DIGITS: HR, MIN, SEC
       OUTPUT ........................... 1-OUT-OF-N AND/OR BCD CODE
       PROGRAMMER ....................... TIME PROGRAMS (COUNT DOWN) AND
                                          TIME SIGNALS
    DATATRON                      #3350-506       $1170                 111
       INPUT FREQUENCY.................. 60HZ
       OUTPUTS.......................... VISUAL,BCD
       DISPLAY.......................... HRS,MIN,SEC

    TENNELEC                      #TC545          $550                  111
       COUNT RATE....................... 20MHZ
       TIMEBASE......................... 0.1 OR 0.01SEC
       ACCURACY......................... SAME AS LINE FREQUENCY
       CONFIGURATION.................... NIM COMPATIBLE

498500 TIMER - MISSION                                          AS007   11111
498500
498500 PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-
498500 DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE,
498500 SECOND.
498500
498500    DISPLAY ......................... 7 DIGITS BCD
498500    DISPLAY TYPE .................... LED
498500
    ROHDE AND SCHWARTZ            #HS 6284(110.3226.21)  $12,700        111
       DISPLAY .......................... 9 DIGITS: DAY, HR, MIN, SEC

    DATATRON                      #3350           $1020                 111
       INPUT FREQUENCY.................. 60HZ
       OUTPUTS.......................... VISUAL, BCD
       DISPLAY.......................... HRS,MIN, SEC

    DATATRON                      3C30            $7940                 111
       CHANNELS......................... 32
       TIMING RANGE..................... 5NANOSEC TO 5MICROSEC
       RESOLUTION....................... 1.0E-8

320000 CONTROLLER, THREE-AXIS HAND                              AS008   11132
320000
320000 THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT
320000 POINTING AND INITIAL TARGET ACQUISITION.
320000
320000    CONTROLLED AXES ............... 3
320000
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603006 CIRCUIT BREAKER/DISTRIBUTOR PANEL                      A5009    11131
603006
603006 CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO
603006 THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.
603006
603006    CIRCUIT BREAKERS .............. 18
603006    POWER CAPABILITY .............. 10 AMPS
603006
609003 INDICATORS-CAUTION AND WARNING                         A5010    11132
609003
609003 A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF
609003 SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.
609003
609003    INDICATORS ..................... 40
609003               ................... MASTER ALARM MEMORY
609003               ................... POWER/TEST CONTROLS
609003
424000 RECORDER-TAPE                                          A5011    11111
424000
424000 RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND
424000 DISPLAY CONSOLE.
424000
424000    BANDWIDTH ...................... DC TO 200 KHZ
424000    CHANNELS ....................... 14
424000    TIME MARKS ..................... EDGE TRACK
424000    RECORDED FORMAT ................ DIGITAL
424000
    HEWLETT PACKARD              #7970B/C          $4600          111
        TAPE FORMAT ..................... 800, 556 OR 200 CPI NRZI AND
                                          1600 CPI PHASE ENCODED
        TRACKS .......................... 7 OR 9
        TAPE SPEED ...................... 10 TO 45 IPS
        TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                          COMPATIBLE

    SANGAMO ELECTRIC             #SABER III        $26,500        111
        TRACKS .......................... 14
        TAPE WIDTH ...................... 1 INCH
        TAPE SPEEDS ..................... 8 SELECTABLE SPEEDS FROM 15/16
                                          TO 120 IPS
        FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
        RECORDING RATE................... 600 KBPS AT 120 IPS SERIAL MODE
        WEIGHT........................... 100 POUNDS

    LEACH                        #MTR 7000                        311
        TRACKS .......................... 12
        TAPE SPEED ...................... 120 IPS
        TAPE WIDTH ...................... 1 INCH
        TAPE LENGTH...................... 9200 FEET
        PACKING DENSITY.................. 16.7 KB/I/T
        SIGNAL/NOISE .................... 22 DB
        DATA CAPACITY ................... 2.2E+10
        BANDWIDTH ....................... 2 MB/SEC/T

    BORG WARNER                  #PERT                            121
        TRACKS .......................... 30
        TAPE SPEED ...................... UP TO 1000 IPS
        TAPE WIDTH ...................... 1/2 INCH
        TAPE LENGTH ..................... 2400 FEET
        PACKING DENSITY ................. 15 KB/I/T
        SIGNAL/NOISE .................... 24 DB
        DATA CAPACITY ................... 1.3E+9
        BANDWIDTH ....................... 6-15 MB/SEC/T

    AMPEX CORP                   #AR 1700          $28,000        112
        TRACKS .......................... 14
        TAPE SPEED ...................... 120 IPS
        TAPE WIDTH ...................... 1 INCH
        RECORDING MODE................... DIRECT
        PACKING DENSITY ................. 20 KB/I/T
        SIGNAL/NOISE .................... 20 DB
        DATA CAPACITY ................... 6.2E+10 BITS
        BANDWIDTH ....................... 2 MB/SEC/T
        TAPE LENGTH.......................9200 FEET

    AMPEX CORPORATION            #AR-200                          121
        BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                          300 HZ TO 250 KHZ
        TAPE WIDTH ...................... 0.5 INCH
        TAPE SPEED ...................... 1.875 TO 60 IPS
        RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
        FORMAT .......................... DIGITAL
        TRACKS............................8 DIGITAL, 7 ANALOG

    AMPEX CORP                   #AR 700           $29,180        511
        TRACKS .......................... 14
        TAPE SPEED ...................... 60 IPS
        TAPE WIDTH ...................... 1 INCH
        RECORD MODE...................... DIRECT
        PACKING DENSITY ................. 20 KB/I/T
        SIGNAL/NOISE .................... 20 DB
        DATA CAPACITY ................... 8E+10 BITS
        BANDWIDTH ....................... 1 MB/SEC/T

    DIGI-DATA CORPORATION        #1600             $2650          111
        TAPE SPEED ...................... 25, 18.75, 12.5 IPS
        TRACKS .......................... 7 OR 9 TRACK
        DATA DENSITY .................... 1600 CPI PHASE ENCODED
                                          200, 556, 800 CPI NRZI
        TAPE ............................ 0.5 INCH, 1.5 MIL, 1200 FEET
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DIGI-DATA CORPORATION #1700/PDP-11/7-9 $5250 111
TRACK NRZI
TAPE SPEED .... 45, 37.5, 25, 18.75, 12.5 IPS
TAPE .... 0.5 INCH, 1.5 MIL, IBM/ANSI
COMPATIBLE, 10.5 INCH REEL
TRACKS .... 7 OR 9 TRACK
DATA DENSITY .... PHASE ENCODED

HONEYWELL #96 $17420
CHANNELS.......................... 7
SELECTABLE TAPE SPEED RANGE...... 15/16 TO 240IPS
REEL SIZE......................... 16IN
MAXIMUM BANDWIDTH(DIRECT)........ 2M HZ
TAPE WIDTH........................ 1/2 IN

HONEYWELL #5600 $9730
PORTABLE TAPE RECORDER
CHANNELS.......................... 7
SELECTABLE TAPE SPEED RANGE...... 15/16 TO 60IPS
MAXIMUM BANDWIDTH(DIRECT)........ 300KHZ
PACKING DENSITY................... UP TO 600BPI
WEIGHT............................ 70LBS (32KG)
INPUT VOLTAGE.....................28VDC

HEWLETT PACKARD #3955D $10200 111
BANDWIDTH .... 300 KHZ
CHANNELS 7
RECORDING FORMAT .... DIRECT OR FM

HEWLETT PACKARD #3955C $14700 111
BANDWIDTH .... 300 KHZ
CHANNELS 14
RECORDING FORMAT .... DIRECT OR FM

HEWLETT PACKARD #3950A-011 $23800 111
BANDWIDTH .... 500 HZ TO 2 MHZ
CHANNELS 14
RECORDING FORMAT .... DIRECT OR FM

HEWLETT PACKARD #3960A/13065A/13063A $4795 111
CONFIGURATION .... RACK MOUNTED
TAPE SPEED .... 15, 7 AND 3/4, 15/16 IPS
CHANNELS 4
RECORDING FORMAT .... FM
PASSBAND .... 5 KHZ
S/N RATIO......................... 40 DB
TRACKS 30

601002 ANNUNCIATORS-ADVISORY AS012 21132
601002
601002 DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL
601002 ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD
601002 EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.
601002
601002 ANNUNCIATOR-VISUAL .... 12 IN DUAL BANKS
601002 DISPLAY TYPE .... RED, WHITE, GREEN
601002 ANNUNCIATOR-AUDIO .... HORN
601002

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HIGH ENERGY PHYSICS

104180 DISPLAY CRT (CONTROL/DISPLAY CONSOLE)                    HE001   21111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND
104180 STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180    SCREEN SIZE .................... 14 IN (0.355 M)
104180
     RESEARCH INC                  #3300               $1580
        FORMAT...........................24 LINESX72 OR 80 CHARACTERS
              ...........................24 LINESX40 CHARACTERS
              ......... ................ 12 LINESX72 OR 80 CHARACTERS
        REFRESH RATE.....................60 HZ
        TRANSFER RATE....................110 TO 2400 BAUD
        CHARACTER FORM...................5X7 DOT MATRIX
        DIMENSIONS.......................15-1/2WX13-1/2HX23-1/2D INCH
        WEIGHT...........................39LB (17.7KG)

     HEWLETT PACKARD               #2600A              $3580          111

     RESEARCH INC                  #812-3301           $1555          111
        SCREEN FORMAT .................. 12 LINES X 72 OR 80 CHARACTERS,
                                         24 LINES X 40 CHARACTERS
        CHARACTER FORMAT ............... 5 X 7 DOT MATRIX
        TRANSFER RATE .................. 110 TO 2400 BAUD, 10 OR 11 BIT
                                         CHARACTERS
        MODES .......................... HALF OR FULL DUPLEX-SWITCHABLE
                                         LOCAL OR REMOTE

     RESEARCH INC                  #DPS-812           $21,700         111
        COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
        CEC-PDP8-F MINS-COMPUTER, #3301 OPERATIORS CONTROL CONSOLE,
        PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
        CHANNELS ....................... 32
        MEMORY SIZE .................... 8K WORDS

104020 SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE)      HE002   11111
104020
104020 PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT
104020
104020    CHANNELS ..................... 2
104020    FORMAT ....................... VIDEO AND DATA
104020    VIDEO INPUT PRESENTATION ..... RASTER SCAN
104020    SYMBOL WRITING TECHNIQUE ..... STROKE
104020    INTERFACE DESCRIPTION ........ DIGITAL-12-BIT DATAWORD
104020
     TEKTRONIC                     #4002A/021-00XX-00   $9550         111
        DISPLAY MEDIUM ................. 11 INCH DIRECT-VIEW, BISTABLE
                                         STORAGE CRT WITH REFRESHED
                                         SCRATCH PAD AREA
        DISPLAY AREA ................... 6.3 INCHES HORIZONTAL X 6.1
                                         INCHES VERTICAL
        ALPHANUMERIC MODE
           FORMAT ...................... 39 LINES OF 85 NORMAL OR ITALIC
                                         CHARACTERS IN MAIN AREA, ONE
                                         LINE OF 84 CHARACTERS IN
                                         SCRATCH PAD AREA
           CHARACTER SET ............... 96 UPPER AND LOWER CASE PRINT-
                                         ING CHARACTERS (ASCII CODE)
           CHARACTER SIZE .............. 70X90 MILS (CAN BE DOUBLE SIZE)
           CHARACTER GENERATION ........ 7X9 DOT MATRIX
           CURSOR ...................... PULSATING 7X9 MATRIX
        GRAPHIC MODES .................. LINEAR INTERPOLATE, INCREMENTAL
                                         PLOT, POINT PLOT, 1024X1024
                                         ADDRESSABLE POINTS, 1024X761
                                         VIEWABLE POINTS
        GRAPHIC INPUT MODE ............. 1024 (X), 761 (Y) POINTS. JOY-
                                         STICK CONTROLLED, CROSS-HAIR
                                         CURSOR

101340 FUNCTION KEYBOARD                                        HE003   11111
101340
101340 ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO
101340 DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY,
101340 FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.
101340
101340    KEYBOARD ..................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
     BUNKER-RAMO CORP              #2200                $440          111
        KEYS ........................... TYPEWRITER SET STD
        PROGRAM ASSIST KEYS ............ 16
        INTERFACE ...................... CRT
        EDITING KEYS ................... FULL SET

101340 ALPHANUMERIC KEYBOARD                                    HE004   11111
101340
101340 ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ..................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ........ DIGITAL-32-BIT WORD
101340
     BUNKER-RAMO CORP              #2200                $440          111
        KEYS ........................... TYPEWRITER SET STD
        PROGRAM ASSIST KEYS ............ 16
        INTERFACE ...................... CRT
        EDITING KEYS ................... FULL SET
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164000 MICROFILM VIEWER                                    HE005   11111
164000
164000 PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-
164000 SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES,
164000 SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.
164000
164000    FILM FORMAT .................... 16 MM DUAL TRACK
164000    FILM LOADING ................... CASETTE
164000    FILM SLEWING ................... MANUAL AND COMPUTER SELECT
164000    INTERFACE DESCRIPTION ......... DIGITAL 13-BIT BINARY
164000
    CALMA CO.                   #3C3M               $28000         111
       FUNCTION ...................... OFF LINE DIGITIZING SYSTEM
                                       WITH FILM PROJECTION.
                                       PROVIDES CAPABILITY OF
                                       DIGITIZING FILM DATA

498200 TIMER - EVENT                                       HE006   11111
498200
498200 DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR
498200 EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE
498200 START AND STOP COMMANDS (MINUTES AND SECONDS).
498200
498200    DISPLAY ........................ 4 DIGITS
498200    DISPLAY TYPE ................... LED
498200    INTERFACE ...................... DISCRETE
498200
    ROHDE AND SCHWARZ           #CAD (100.6597.91)  $5400          111
       DISPLAY ....................... 6 DIGITS: HRS, MINS, SECS
       OUTPUT ........................ 1-OUT-OF-N AND/OR BCD CODE

    CATATRON                    #3350-506           $1170          111
       INPUT FREQUENCY................ 60HZ
       OUTPUTS........................ VISUAL,BCD
       DISPLAY........................ HRS,MIN,SEC

    TENNELEC                    #TC545              $550           111
       COUNT RATE..................... 20MHZ
       TIMEBASE....................... 0.1 OR 0.01SEC
       ACCURACY....................... SAME AS LINE FREQUENCY
       CONFIGURATION.................. NIM COMPATIBLE

498500 TIMER - MISSION                                     HE007   11111
498500
498500 PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-
498500 DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE,
498500 SECOND.
498500
498500    DISPLAY ........................ 7 DIGITS BCD
498500    DISPLAY TYPE ................... LED
498500
    ROHDE AND SCHWARZ           #HS 6284(110.3226.21)  $12,730     111
       DISPLAY ....................... 9 DIGITS: DAY, HR, MIN, SEC

    CATATRON                    #3350               $1020          111
       INPUT FREQUENCY................ 60HZ
       OUTPUTS........................ VISUAL, BCD
       DISPLAY........................ HRS, MIN, SEC

    DATATRON                    3030                $7940          111
       CHANNELS....................... 32
       TIMING RANGE................... 5NANOSEC TO 5MICROSEC
       RESOLUTION..................... 1.0E-8

320000 CONTROLLER, THREE-AXIS HAND                         HE008   11132
320000
320000 THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT
320000 POINTING AND INITIAL TARGET ACQUISITION.
320000
320000    CONTROLLED AXES ................ 3
320000
603006 CIRCUIT BREAKER/DISTRIBUTOR PANEL                   HE009   11131
603006
603006 CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO
603006 THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.
603006
603006    CIRCUIT BREAKERS ............... 18
603006    POWER CAPABILITY ............... 10 AMPS
603006
609003 INDICATORS-CAUTION AND WARNING                      HE010   11132
609003
609003 A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF
609003 SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.
609003
609003    INDICATORS ..................... 40
609003               ..................... MASTER ALARM MEMORY
609003               ..................... POWER/TEST CONTROLS
609003
424000 RECORDER-TAPE                                       HE011   11111
424000
424000 RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND
424000 DISPLAY CONSOLE.
424000
424000    BANDWIDTH ...................... DC TO 200 KHZ
424000    CHANNELS ....................... 14
424000    TIME MARKS ..................... EDGE TRACK
424000    RECORDED FORMAT ................ DIGITAL
424000
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HEWLETT PACKARD                  #7970B/C             $4600        111
    TAPE FORMAT .....................  800, 556, OR 200 CPI NRZI AND
                                       1600 CPI PHASE ENCODED
    TRACKS ..........................  7 OR 9
    TAPE SPEED ......................  10 TO 45 IPS
    TAPE ............................  0.5 INCH, 1.5 MIL, IBM/ANSI
                                       COMPATIBLE

SANGAMO ELECTRIC                 #SABER III           $26,500      111
    TRACKS ..........................  14
    TAPE WIDTH ......................  1 INCH
    TAPE SPEEDS .....................  8 SELECTABLE SPEEDS FROM 15/16
                                       TO 120 IPS
    FREQUENCY RESPONSE ..............  400 HZ TO 2.0 MHZ
    RECORDING RATE ..................  600 KBPS AT 120 IPS SERIAL MODE
    WEIGHT ..........................   100 POUNDS

LEACH                            #MTR 7000                         311
    TRACKS ..........................  12
    TAPE SPEED ......................  120 IPS
    TAPE WIDTH ......................  1 INCH
    TAPE LENGTH......................  9200 FEET
    PACKING DENSITY..................  16.7 KB/I/T
    SIGNAL/NOISE ....................  22 DB
    DATA CAPACITY ...................  2.2E+10
    BANDWIDTH .......................  2 MB/SEC/T

BORG WARNER                      #PERT                             121
    TAPE SPEED ......................  UP TO 1000 IPS
    TRACKS...........................30
    TAPE WIDTH ......................  1/2 INCH
    TAPE LENGTH .....................  2400 FEET
    PACKING DENSITY .................  15 KB/I/T
    SIGNAL/NOISE ....................  24 DB
    DATA CAPACITY ...................  1.3E+9
    BANDWIDTH .......................  6-15 MB/SEC/T

AMPEX CORP                       #AR 700              $29,180      511
    TRACKS ..........................  14
    TAPE SPEED ......................  60 IPS
    TAPE WIDTH ......................  1 INCH
    RECORD MODE......................  DIRECT
    PACKING DENSITY .................  20 KB/I/T
    SIGNAL/NOISE ....................  20 DB
    DATA CAPACITY ...................  8E+10 BITS
    BANDWIDTH .......................  1 MB/SEC/T

AMPEX CORP                       #AR 1700             $28000       112
    TRACKS ..........................  28
    TAPE SPEED ......................  120 IPS
    TAPE WIDTH ......................  1 INCH
    TAPE LENGTH .....................  9200 FEET
    PACKING DENSITY .................  20 KB/I/T
    SIGNAL/NOISE ....................  20 DB
    DATA CAPACITY ...................  6.2E+10
    BANDWIDTH .......................  2 MB/SEC/T

AMPEX CORPORATION                #AR-200                           121
    BANDWIDTH .......................  100 HZ TO 3125 HZ THROUGH
                                       300 HZ TO 250 KHZ
    TAPE WIDTH ......................  0.5 INCH
    TAPE SPEED ......................  1.875 TO 60 IPS
    RECORDING TIME ..................  8 MINUTES TO 4 HRS AND 16 MINS
    FORMAT ..........................  DIGITAL
    TRACKS ..........................  8 DIGITAL, 7 ANALOG

DIGI-DATA CORPORATION            #1600                $26[illegible]       111
    TAPE SPEED ......................  25, 18.75, 12.5 IPS
    TRACKS ..........................  7 OR 9 TRACK
    DATA DENSITY ....................  1600 CPI PHASE ENCODED
                                       200, 556, 800 CPI NRZI
    TAPE ............................  0.5 INCH, 1.5 MIL [illegible]00 FEET

DIGI-DATA CORPORATION            #1700/PDP-11/7-9     $5250        111
                                  TRACK NRZI
    TAPE SPEED ......................  45, 37.5, 25, 18.[illegible], 12.5 IPS
    TAPE ............................  0.5 INCH, 1.5 MIL, IBM/ANSI
                                       COMPATIBLE, 10.5 INCH REEL
    TRACKS ..........................  7 OR 9 TRACK
    DATA DENSITY ....................  PHASE ENCODED

HONEYWELL                        #96                  $17420
    CHANNELS.........................  7
    SELECTABLE TAPE SPEED RANGE......  15/16 TO 240IPS
    REEL SIZE........................  16IN
    MAXIMUM BANDWIDTH(DIRECT)........  2M HZ
    TAPE WIDTH.......................  1/2 IN

HONEYWELL                        #5600                $9730
    PORTABLE TAPE RECORDER
    CHANNELS.........................  7
    SELECTABLE TAPE SPEED RANGE......  15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)........  300KHZ
    PACKING DENSITY..................  UP TO 600PBI
    WEIGHT...........................  70LBS (32KG)
    INPUT VOLTAGE....................28VDC
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HEWLETT PACKARD                  #3955D              $10200       111
     BANDWIDTH ......................... 300 KHZ
     CHANNELS .......................... 7
     RECORDING FORMAT .................. DIRECT OR FM

HEWLETT PACKARD                  #3955C              $14700       111
     BANDWIDTH ......................... 300 KHZ
     CHANNELS .......................... 14
     RECORDING FORMAT .................. DIRECT OR FM

HEWLETT PACKARD                  #3950A-C11          $23800       111
     BANDWIDTH ......................... 500 HZ TO 2 MHZ
     CHANNELS .......................... 14
     RECORDING FORMAT .................. DIRECT OR FM

HEWLETT PACKARD                  #3960A/13065A/13063A $4796       111
     CONFIGURATION ..................... RACK MOUNTED
     TAPE SPEED ........................ 15, 3 AND 3/4, 15/16 IPS
     CHANNELS .......................... 4
     RECORDING FORMAT .................. FM
     PASSBAND .......................... 5 KHZ
     S/N RATIO.......................... 48 DB
     TRACKS ............................ 30

601002 ANNUNCIATORS-ADVISORY                               HE012   21132
601002
601002 DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL
601002 ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD
601002 EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.
601002
601002    ANNUNCIATOR-VISUAL ........... 12 IN DUAL BANKS
601002    DISPLAY TYPE ................. RED, WHITE, GREEN
601002    ANNUNCIATOR-AUDIO ............ HORN
601002
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SCLAR PHYSICS

104180 DISPLAY CRT (CONTROL/DISPLAY CONSOLE)                  SC001   21111
104180
104180 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS, DYNAMIC AND
104180 STATIC GRAPHICS, VECTORS, CIRCLES, AND SPECIAL SYMBOLS. INCLUDES
104180 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104180
104180    SCREEN SIZE .................. 14 IN (0.355 M)
104180
   HEWLETT PACKARD               #2600A              $3580          111

   RESEARCH INC                  #3300               $1580
      FORMAT..........................24 LINESX72 OR 80 CHARACTERS
          ............................24 LINESX40 CHARACTERS
          ........ .................. 12 LINESX72 OR 80 CHARACTERS
      REFRESH RATE....................60 HZ
      TRANSFER RATE...................110 TO 2400 BAUD
      CHARACTER FORM..................5X7 DOT MATRIX
      DIMENSIONS......................15-1/2WX13-1/2HX23-1/2D INCH
      WEIGHT..........................39LB (17.7KG)

   RESEARCH INC                  #812-3301           $1555          111
      SCREEN FORMAT ................. 12 LINES X 72 OR 80 CHARACTERS,
                                      24 LINES X 40 CHARACTERS
      CHARACTER FORMAT .............. 5 X 7 DOT MATRIX
      TRANSFER RATE ................. 110 TO 2400 BAUD, 10 OR 11 BIT
                                      CHARACTERS
      MODES ......................... HALF OR FULL DUPLEX-SWITCHABLE
                                      LOCAL OR REMOTE

   RESEARCH INC                  #DPS-812            $21,700        111
      COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
      DEC-PDP8-F MINI-COMPUTER, #3301 OPERATIONS CONTROL CONSOLE,
      PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
      CHANNELS ...................... 32
      MEMORY SIZE ................... 8K WORDS

104020 SYMBOL GENERATOR UNIT (CONTROL/DISPLAY CONSOLE)        SC002   11111
104020
104020 PROVIDES VIDEO AND COMPUTER DATA INTERFACE TO THE CRT
104020
104020    CHANNELS ...................... 2
104020    FORMAT ........................ VIDEO AND DATA
104020    VIDEO INPUT PRESENTATION ...... RASTER SCAN
104020    SYMBOL WRITING TECHNIQUE ...... STROKE
104020    INTERFACE DESCRIPTION ......... DIGITAL-12-BIT DATAWORD
104020
   TEKTRONIC                     #4002A/C21-COXX-00  $9550          111
      DISPLAY MEDIUM ................ 11 INCH DIRECT-VIEW, BISTABLE
                                      STORAGE CRT WITH REFRESHED
                                      SCRATCH PAD AREA
      DISPLAY AREA .................. 8.3 INCHES HORIZONTAL X 6.1
                                      INCHES VERTICAL
      ALPHANUMERIC MODE
         FORMAT ..................... 39 LINES OF 85 NORMAL OR ITALIC
                                      CHARACTERS IN MAIN AREA, ONE
                                      LINE OF 84 CHARACTERS IN
                                      SCRATCH PAD AREA
         CHARACTER SET .............. 96 UPPER AND LOWER CASE PRINT-
                                      ING CHARACTERS (ASCII CODE)
         CHARACTER SIZE ............. 70X90 MILS (CAN BE DOUBLE SIZE)
         CHARACTER GENERATION ....... 7X9 DOT MATRIX
         CURSOR ..................... PULSATING 7X9 MATRIX
      GRAPHIC MODES ................. LINEAR INTERPOLATE, INCREMENTAL
                                      PLOT, POINT PLOT, 1024X1024
                                      ADDRESSABLE POINTS, 1024X761
                                      VIEWABLE POINTS
      GRAPHIC INPUT MODE ............ 1024 (X), 761 (Y) POINTS, JOY-
                                      STICK CONTROLLED, CROSS-HAIR
                                      CURSOR

101340 FUNCTION KEYBOARD                                       SD003   11111
101340
101340 ALLOWANCE BY CREWMAN TO CONFIGURE EXPERIMENTS AND SUBSYSTEMS INTO
101340 DESIRED OPERATING MODES. THESE INCLUDE SELECTION OF CATEGORY,
101340 FUNCTION, MODE, STATUS AND COMMON KEYBOARD FUNCTIONS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ......... DIGITAL-32-BIT WORD
101340
   BUNKER-RAMO CORP              #2200               $440           111
      KEYS .......................... TYPEWRITER SET STD
      PROGRAM ASSIST KEYS ........... 16
      INTERFACE ..................... CRT
      EDITING KEYS .................. FULL SET

101340 ALPHANUMERIC KEYBOARD                                   SD004   11111
101340
101340 ALLOWANCE BY CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ...................... TYPEWRITER TYPE
101340    INTERFACE DESCRIPTION ......... DIGITAL-32-BIT WORD
101340
   BUNKER-RAMO CORP              #2200               $440           111
      KEYS .......................... TYPEWRITER SET STD
      PROGRAM ASSIST KEYS ........... 16
      INTERFACE ..................... CRT
      EDITING KEYS .................. FULL SET
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ORIGINAL PAGE IS
OF POOR QUALITY

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164000 MICROFILM VIEWER                                    S0005   11111
164000
164000 PROVIDES READ-ONLY, PROCEDURAL-TYPE DATA FOR EXPERIMENT AND SUB-
164000 SYSTEM OPERATIONAL PROCEDURES, ONBOARD CHECKOUT PROCEDURES,
164000 SIMPLEX SCHEMATICS AND OTHER WRITTEN OR PICTORIAL INFORMATION.
164000
164000    FILM FORMAT .................... 16 MM DUAL TRACK
164000    FILM LOADING ................... CASETTE
164000    FILM SLEWING ................... MANUAL AND COMPUTER SELECT
164000    INTERFACE DESCRIPTION .......... DIGITAL 13-BIT BINARY
164000
    CALMA CO.                    #303M                $28000          111
        FUNCTION ......................... OFF LINE DIGITIZING SYSTEM
                                           WITH FILM PROJECTION.
                                           PROVIDES CAPABILITY OF
                                           DIGITIZING FILM DATA

498200 TIMER - EVENT                                       S0006   11111
498200
498200 DIGITAL DISPLAY OF TIME REMAINING OR EXPENDED FOR A PARTICULAR
498200 EVENT. TIMER CAPABLE OF COUNTING UP OR DOWN AND PROVIDES DISCRETE
498200 START AND STOP COMMANDS (MINUTES AND SECONDS).
498200
498200    DISPLAY ........................ 4 DIGITS
498200    DISPLAY TYPE ................... LED
498200
    ROHDE AND SCHWARZ            #CAD (100.6597.91)   $5400           111
        DISPLAY .......................... 6 DIGITS: HR, MIN, SEC
        OUTPUT ........................... 1-OUT-OF-N AND/OR BCD CODE
        PROGRAMMER.........................TIME PROGRAMS(COUNT
                                           DOWN) AND TIME SIGNALS

    DATATRON                     #3350-SC6         $1170              111
        INPUT FREQUENCY................... 60HZ
        OUTPUTS........................... VISUAL,BCD
        DISPLAY........................... HRS,MIN,SEC

    TENNELEC                     #TC545            $550               111
        COUNT RATE........................ 20MHZ
        TIMEBASE.......................... 0.1 OR 0.01SEC
        ACCURACY.......................... SAME AS LINE FREQUENCY
        CONFIGURATION..................... NIM COMPATIBLE

498500 TIMER - MISSION                                     S0007   11111
498500
498500 PROVIDES TIME REFERENCE IN GREENWICH MEAN TIME WITH 1 SECOND UP-
498500 DATE MAINTAINED VIA DATA MANAGEMENT COMPUTER - DAY,HOUR,MINUTE,
498500 SECOND.
498500
498500    DISPLAY ........................ 7 DIGITS BCD
498500    DISPLAY TYPE ................... LED
498500
    ROHDE AND SCHWARTZ           #HS 6284(110.3226.21)   $12,700      111
        DISPLAY .......................... 9 DIGITS: DAY, HR, MIN, SEC

    DATATRON                     #3350             $1020
        INPUT FREQUENCY................... 60HZ
        OUTPTS............................ VISUAL, BCD
        DISPLAY........................... HRS, MIN, SEC

    DATATRON                     3030              $7940              111
        CHANNELS.......................... 32
        TIMING RANGE...................... 5NANOSEC TO 5MICROSEC
        RESOLUTION........................ 1.0E-8

320000 CONTROLLER, THREE-AXIS HAND                         SC008   11132
320000
320000 THREE-AXIS MULTIFUNCTION HAND CONTROLLER PROVIDED FOR INSTRUMENT
320000 POINTING AND INITIAL TARGET ACQUISITION.
320000
320000    CONTROLLED AXES ................ 3
320000
603006 CIRCUIT BREAKER/DISTRIBUTOR PANEL                   SC009   11131
603006
603006 CENTRAL LOCATION OF CIRCUIT BREAKERS AND POWER DISTRIBUTION TO
603006 THOSE STANDARD ITEMS FOUND IN ALL ASTRONOMY EXPERIMENTS.
603006
603006    CIRCUIT BREAKERS ............... 18 EACH
603006    POWER CAPABILITY ............... 10 AMPS
603006
609003 INDICATORS-CAUTION AND WARNING                      S0010   11132
609003
609003 A REDUNDANT ISOLATED SYSTEM WHICH MONITORS AND GIVES WARNING OF
609003 SUBSYSTEM AND EXPERIMENT EQUIPMENT FAILURE AND/OR MALFUNCTION.
609003
609003    INDICATORS ..................... 40
609003               ..................... MASTER ALARM MEMORY
609003               ..................... POWER/TEST CONTROLS
609003
424000 RECORDER-TAPE                                       S0011   11111
424000
424000 RECORDING OF SELECTED PARAMETERS DISPLAYED ON THE CONTROL AND
424000 DISPLAY CONSOLE.
424000
424000    BANDWIDTH ...................... DC TO 200 KHZ
424000    CHANNELS ....................... 14
424000    TIME MARKS .....................EDGE TRACK
424000    RECORDED FORMAT ................ DIGITAL
424000
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HEWLETT PACKARD                  #7970R/C            $ 4600        111
    TAPE FORMAT .......................... 800, 556, OR 200 CPI NRZI AND
                                           1600 CPI PHASE-ENCODED
    CHANNELS ............................. 7 OR 9
    TAPE SPEED ........................... 10 TO 45 IPS
    TAPE ................................. 0.5 INCH, 1.5 MILS, IBM/ANSI
                                           COMPATIBLE

SANGAMO ELECTRIC                 #SABER III          $26,500       111
    TRACKS................................ 14
    TAPE WIDTH ........................... 1 INCH
    TAPE SPEEDS .......................... 8 SELECTABLE SPEEDS FROM 15/16
                                           TO 120 IPS
    FREQUENCY RESPONSE ................... 400 HZ TO 2.0 MHZ
    RECORDING RATE........................ 600 KBPS AT 120 IPS SERIAL MODE
    WEIGHT................................100 POUNDS

LEACH                            #MTR 7000                         311
    TRACKS ............................... 12
    TAPE SPEED ........................... 120 IPS
    TAPE WIDTH ........................... 1 INCH
    TAPE LENGTH........................... 9200 FEET
    PACKING DENSITY....................... 16.7 KB/I/T
    SIGNAL/NOISE ......................... 22 DB
    CATA CAPACITY ........................ 2.2E+10 BITS
    BANDWIDTH ............................ 2 MB/SEC/T

BORG WARNER                      #PERT                             121
    TRACKS ............................... 30
    TAPE SPEED ........................... UP TO 1000 IPS
    TAPE WIDTH ........................... 1/2 INCH
    TAPE LENGTH .......................... 2400 FEET
    PACKING DENSITY ...................... 15 KB/I/T
    SIGNAL/NOISE ......................... 24 DB
    CATA CAPACITY ........................ 1.3E+9 BITS
    BANDWIDTH ............................ 6-15 MB/SEC/T

AMPEX CORP                       #AR 1700            $28,000       112
    TRACKS ............................... 14
    TAPE SPEED ........................... 120 IPS
    TAPE LENGTH...........................9200 FEET
    TAPE WIDTH ........................... 1 INCH
    RECORDING MODE........................ DIRECT
    PACKING DENSITY ...................... 20 KB/I/T
    SIGNAL/NOISE ......................... 20 DB
    CATA CAPACITY ........................ 6.2E+10
    BANDWIDTH ............................ 2 MB/SEC/T

AMPEX CORP                       #AR 700             $29,180       511
    TRACKS ............................... 14
    TAPE SPEED ........................... 60 IPS
    TAPE WIDTH ........................... 1 INCH
    RECORDING MODE........................ DIRECT
    PACKING DENSITY ...................... 20 KB/I/T
    SIGNAL/NOISE ......................... 20 DB
    CATA CAPACITY ........................ 8E+10 BITS
    BANDWIDTH ............................ 1 MB/SEC/T

AMPEX CORPORATION                #AR-200                           121
    BANDWIDTH ............................ 100 HZ TO 3125 HZ THROUGH
                                           300 HZ TO 250 KHZ
    TAPE WIDTH ........................... 0.5 INCH
    TAPE SPEED ........................... 1.875 TO 60 IPS
    RECORDING TIME ....................... 8 MINUTES TO 4 HRS AND 16 MINS
    FORMAT ............................... DIGITAL
    TRACKS ............................... 8 DIGITAL, 7 ANALOG

DIGI-DATA CORPORATION            #1600               $2650         111
    TAPE SPEED ........................... 25, 18.75, 12.5 IPS
    TRACKS ............................... 7 OR 9 TRACK
    DATA DENSITY ......................... 1600 CPI PHASE ENCODED
                                           200, 556, 800 CPI NRZI
    TAPE ................................. 0.5 INCH, 1.5 MIL, 1200 FEET

DIGI-DATA CORPORATION            #1700/PDP-11/7-9    $5250         111
                                   TRACK NRZI
    TAPE SPEED ........................... 45, 37.5, 25, 18.75, 12.5 IPS
    TAPE ................................. 0.5 INCH, 1.5 MIL, IBM/ANSI
                                           COMPATIBLE, 10.5 INCH REEL
    TRACKS ............................... 7 OR 9 TRACK
    DATA DENSITY ......................... PHASE ENCODED

HONEYWELL                        #96                 $17420
    CHANNELS.............................. 7
    SELECTABLE TAPE SPEED RANGE........... 15/16 TO 240IPS
    REEL SIZE............................. 16IN
    MAXIMUM BANDWIDTH(DIRECT)............. 2M HZ
    TAPE WIDTH............................ 1/2 IN

HONEYWELL                        #5600               $9730
    PORTABLE TAPE RECORDER
    CHANNELS.............................. 7
    SELECTABLE TAPE SPEED RANGE........... 15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)............. 300KHZ
    PACKING DENSITY....................... UP TO 600PBI
    WEIGHT................................ 70LBS (32KG)
    INPUT VOLTAGE.........................28VDC
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HEWLETT PACKARD #3955D $10200 111
BANDWIDTH .... 300 KHZ
CHANNELS 7
RECORDING FORMAT .... DIRECT OR FM

HEWLETT PACKARD #3955C $14700 111
BANDWIDTH .... 300 KHZ
CHANNELS 14
RECORDING FORMAT .... DIRECT OR FM

HEWLETT PACKARD #3950A-011 $23800 111
BANDWIDTH .... 500 HZ TO 2 MHZ
CHANNELS 14
RECORDING FORMAT .... DIRECT OR FM

HEWLETT PACKARD #3960A/13065A/13063A $4796 111
CONFIGURATION .... RACK MOUNTED
TAPE SPEED .... 15, 3 AND 3/4, 15/16 IPS
CHANNELS 4
RECORDING FORMAT .... FM
PASSBAND .... 5 KHZ
S/N RATIO......................... 40 DB
TRACKS 30

601002 ANNUNCIATORS-ADVISORY SC012 21132
601002
601002 DUAL BANKS MOUNTED ON CONTROL/DISPLAY CONSOLE PROVIDING VISUAL
601002 ALERT CUE WHEN A LOW PRIORITY MALFUNCTION OCCURS IN ANY ONBOARD
601002 EXPERIMENT OR OTHER DESIGNATED MODULE SUBSYSTEM.
601002
601002 ANNUNCIATOR-VISUAL .... 12 IN DUAL BANKS
601002 DISPLAY TYPE .... RED, WHITE, GREEN
601002 ANNUNCIATOR-AUDIO .... HORN
601002

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ATMOSPHERIC AND SPACE PHYSICS

404000 BOOM POSITION TV DISPLAY                          AP801   11111
404000
404000 DISPLAY MEDIUM RESOLUTION TELEVISION OF EXPERIMENT BOOM POSITIONS
404000 BEFORE, DURING AND AFTER EACH EXPERIMENT REPETITION.
404000
404000    RESOLUTION .................. .... 525 LINES
404000    FRAME RATE .................. ....  30 FRAMES/SEC
404000    BANDWIDTH .......................... VHF RANGE
404000
     COHU ELECTRONICS INC          #COF                $775          111
        AP-05      801       1
       BANDWIDTH ......................... 30 MHZ
       HORIZONTAL LINES .................. 1225
       FIELDS ............................ 60 PER SEC

     CONRAC CORPORATION            #RQA 14/R           $1620         111
       VIDEO AMPLIFIER
           COMPOSITE ..................... 0.3 - 3.0 V P-P
           NONCOMPOSITE .................. 0.3 V P-P FOR 100 PCT CONTRAST
                                           3.0 V P-P MAXIMUM BEFORE PREAMP
                                           OVERLOAD
       VIDEO INPUT IMPEDANCE ............. 50 K OHM MIN SHUNTED BY MAX 10
                                           PFD SIGNAL OF 20 V P-P; HUM
                                           SUPPRESSION 40 DB 60-1000 HZ
       VIDEO FREQUENCY RESPONSE
           AT 50 PCT OF MODULATION .... FLAT +/- 1 DB  TO 30 MHZ, -6 DB
                                           AT 40 MHZ
           AT 30 PCT OF DEPTH MOD ..... FLAT +/- 1 DB  TO 30 MHZ, -2 DB
                                           AT 40 MHZ
       PULSE RESPONSE .................... LESS THAN 15 NS RISE/FALL TIME
                                           AT 50 PCT DEPTH OF MODULATION
       EXTERNAL SYNC ..................... COMPOSITE OR SEPARATE H/V SYNC:
                                           0.5 V TO 10 V P-P, GREATER THAN
                                           5K OHM INPUT IMPEDANCE
       LINEARITY ......................... +/- 1 PCT PICTURE HEIGTH
       RETRACE TIME
           HORIZONTAL .................... 5 MICROSEC MAX
           VERTICAL ...................... 800 MICROSEC MAX
       SCANNING FREQUENCY
           HORIZONTAL .................... 15 - 40 KHZ
           VERTICAL ...................... 15 - 60 FIELDS/SECOND

     COHU INC. ELECTRONICS DIV     #9600               $5260
       PICTURE SIZE ...................... 7-3/16W X 5-3/8H INCHES
       HORIZONTAL SCAN ................... 945 LINES, 50 OR 60 FIELDS/SEC
                       .................. 873 LINES, 60 FIELDS/SEC
       VIDEO BANDWIDTH ................... 20 MHZ +/- 2 DB
       POWER ............................. 25-28.5 VDC, 150 WATTS

404000 EXPERIMENT TV DISPLAY                             AP802   11111
404000
404000 DISPLAY HIGH RESOLUTION TELEVISION PICTURES OF AREAS OF INTEREST
404000 IN REAL TIME OR FROM VIDEO RECORDERS AT VARIOUS SPEEDS.
404000
404000    RESOLUTION.......................... 525 LINES
404000    FRAME RATE.......................... 30 FPS
404000    BANDWIDTH........................... UHF RANGE
404000
     COHU ELECTRONICS INC.         #COF                $775          111
       BANDWIDTH ......................... 30 MHZ
       HORIZONTAL LINES .................. 1225
       FIELDS ............................ 60/SEC.

     CONRAC CORPORATION            #RQA 14/R           $1620         111
       VIDEO AMPLIFIER
           COMPOSITE ..................... 0.3 - 3.0 V P-P
           NONCOMPOSITE .................. 0.3 V P-P FOR 100 PCT CONTRAST
                                           3.0 V P-P MAXIMUM BEFORE PREAMP
                                           OVERLOAD
       VIDEO INPUT IMPEDANCE ............. 50 K OHM MIN SHUNTED BY MAX 10
                                           PFD SIGNAL OF 20 V P-P; HUM
                                           SUPPRESSION 40 DB 60-1000 HZ
       VIDEO FREQUENCY RESPONSE
           AT 50 PCT OF MODULATION .... FLAT +/- 1 DB  TO 30 MHZ, -6 DB
                                           AT 40 MHZ
           AT 30 PCT OF DEPTH MOD ..... FLAT +/- 1 DB  TO 30 MHZ, -2 DB
                                           AT 40 MHZ
       PULSE RESPONSE .................... LESS THAN 15 NS RISE/FALL TIME
                                           AT 50 PCT DEPTH OF MODULATION
       EXTERNAL SYNC ..................... COMPOSITE OR SEPARATE H/V SYNC:
                                           0.5 V TO 10 V P-P, GREATER THAN
                                           5K OHM INPUT IMPEDANCE
       LINEARITY ......................... +/- 1 PCT PICTURE HEIGTH
       RETRACE TIME
           HORIZONTAL .................... 5 MICROSEC MAX
           VERTICAL ...................... 800 MICROSEC MAX
       SCANNING FREQUENCY
           HORIZONTAL .................... 15 - 40 KHZ
           VERTICAL ...................... 15 - 60 FIELDS/SECOND

     COHU INC. ELECTRONICS DIV     #9600               $5260
       PICTURE SIZE ...................... 7-3/16W X 5-3/8H INCHES
       HORIZONTAL SCAN ................... 945 LINES, 50 OR 60 FIELDS/SEC
                       .................. 873 LINES, 60 FIELDS/SEC
       VIDEO BANDWIDTH ................... 20 MHZ +/- 2 DB
       POWER ............................. 25-28.5 VDC, 150 WATTS
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179500 SPECTRUM ANALYZER                                    [illegible]  11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE RATIO AND
179500 MULTIPLE RATIO OF VARIOUS FREQUENCY SOURCES.
179500
179500     BANDWIDTH ...................... 20 HZ TO 300 KHZ
179500     SENSITIVITY .................... 20 NANOVOLTS
179500     ACCURACY ....................... +/- 0.6 DB
179500
   TEKTRONIX INC                  #1L5 (PLUG-IN UNIT)  $1300          111
       FREQUENCY RANGE ................ 50 HZ TO 1 MHZ
       DEFLECTION FACTOR .............. 1 MV/CM TO 100 V/CM

   HEWLETT PACKARD                #141T/8552B/8556A     $[illegible]   111
       SELECTABLE FREQUENCY SCALES .... 0-30 KHZ, 0-300 KHZ
       FREQUENCY SPECTRUM ............. 20 HZ TO 300 KHZ
       SENSITIVITY .................... 20 NANOVOLT (-142 DBM 50 OHM)
       ABSOLUTE AMPLITUDE ACCURACY .... +/- 0.6 DB
       DISPLAY ........................ 8 DIV LINEAR, 70 DB LOGARITHMIC

   FEDERAL SCIENTIFIC             #UA10                 $3500          111

   SINGER                         #SSB-50-1P            $6900          111
       FREQUENCY RANGE ................10HZ TO 40MHZ
       SENSITIVITY ....................+/- 3DB

179500 MULTI-CHANNEL ANALYZER                                APB04  11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE RATIO AND
179500 MULTIPLE RATIO OF MULTIPLE FREQUENCY SOURCES SIMULTANEOUSLY.
179500
179500     BANDWIDTH ...................... 0 TO 10 MHZ
179500     TIME BASE ...................... 200 MHZ CLOCK
179500     MEMORY SIZE .................... 1024, 4096, 8192 CHANNELS
179500
   HEWLETT/PACKARD                #5401B                $24,250        111
       MADE UP OF 181-1804R OSCILLOSCOPE WITH 5431B DISPLAY PLUG-IN
       5422B DIGITAL PROCESSOR, AND 5416B ANALOG TO DIGITAL CONVERTER
       IN 5610A POWER SUPPLY INTERFACE
       MOUNT........................... BENCH

   NUCLEAR DATA                   # ND 100              $7500
       DATA ACQUISITION MODES ......... PHA, MCS, OR LIST
       BANDWIDTH ...................... 15 MHZ
       STORAGE ........................ 12 BIT DATA  WORDS
       DISPLAY ........................ CRT, 6X10 CM
       NUMBER OF CHANNELS ............. 1024,2048,4096
       COUNT CAPACITY PER CHANNEL ..... 2**20 +7 1 + 4 INTERNAL
                                        FLAG BITS
       DIMENSIONS...................... 19X10.25X23.5 INCHES
       WEIGHT ......................... 60 LBS

179500 WAVE ANALYZER                                         APB05  11111
179500
179500 DETECTION OF SIGNAL AMPLITUDE AND FREQUENCY INFORMATION
179500
179500     BANDWIDTH ...................... 10 TO 600 KHZ
179500     FREQUENCY RESOLUTION ........... 10 HZ
179500     SENSITIVITY .................... 3 MV TO 30 V FS
179500     CHANNELS ....................... 2 MINIMUM
179500
   ROHDE AND SCHWARZ              #EZF (100.8831.52)    $18,495        111
       FREQUENCY RANGE ................ 6 KHZ TO 1.3 MHZ
       SENSITIVITY .................... < 0.5 MICROVOLT

   TEKTRONIX INC                  #1L5 (PLUG-IN UNIT)   $1300          111
       FREQUENCY RANGE ................ 50 HZ TO 1 MHZ
       DEFLECTION FACTOR .............. 1 MV/CM TO 100 V/CM

   HEWLETT PACKARD                #3590A/3594A          $4920          111
       FREQUENCY RANGE ................ 20 HZ TO 620 KHZ
       FREQUENCY ACCURACY ............. +/-(1 HZ + TIME BASE ACCURACY)
                                        FOR 20 HZ TO 62 KHZ BAND
                                        +/-(10 HZ + TIME BASE ACCURACY)
                                        FOR 500 HZ TO 620 KHZ BAND
       FREQUENCY RESOLUTION ........... 1 HZ/MINOR DIV (20 HZ TO 62KHZ)
                                        10 HZ/MINOR DIV (500 HZ-620KHZ)
       AMPLITUDE RANGE ................ 1 MICROVOLT TO 30 VFS,16 RANGES
       BANDWIDTH SPECIFIED ............ 10, 100, 1000, 3100 HZ
       SWEEP RATES .................... 1, 10, 100, 1000, 3100 HZ/S
       MAX SWEEP TIME ................. 820 S +/- 15%
179500 WAVE ANALYZER                                         APB09  11111
179500
179500 DETERMINE ,SEPARATE AND ANALYZE VARIOUS FREQUENCY COMPONENTS OF
179500 INPUT SIGNALS (IE FUNDAMENTAL, HARMONICS, INTERMODULATION PRO-
179500 DUCTS, ETC.).
179500
179500     BANDWIDTH ...................... 1 KHZ TO 1.5 MHZ
179500     FREQUENCY RESOLUTION ........... +/- 1.0 %
179500     SENSITIVITY .................... 10 MV TO 100 V
179500     CHANNELS ....................... 2 MINIMUM
179500
   HEWLETT PACKARD                #312A                 $4275          111
       FREQUENCY RANGE ................ 1 KHZ TO 18 MHZ IN 18 OVERLAP-
                                        PING BANDS, 200 KHZ OVERLAP
       FREQUENCY ACCURACY ............. +/-(10 HZ + TIME-BASE ACCURACY)
       AMPLITUDE RANGE ................ -57 DBM TO 23 DBM FS 50-150 OHM
                                        -107 DBM TO 13 DBM 600 OHM
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219900 PATCH PANEL, COAXIAL                                    AP807   81111
219900
219900 MULTIPLE INPUT PANEL CAPABLE OF CHANNELING HIGH FREQUENCY RF
219900 ENERGY TO APPROPRIATE INSTRUMENTS WITH MINIMUM LOSS AND INTER-
219900 FERENCE.
219900
   TROMPTER ELEC.              #JSI-52              $75          111
       VARIOUS SIZE  PATCH  PANELS, JACKS AND PLUGS ARE AVAILABLE
       FROM TROMPETER, CATALOG SHOULD BE CONSULTED FOR SPECIFIC
       APPLICATION. REVIEW INDICATES ITEMS COULD BE USED DIRECTLY
       IN SPACE

179500 FREQUENCY COUNTER                                       AP808   11111
179500
179500 DIRECT MEASUREMENT OF FREQUENCY AND/OR SIGNAL REPETITION RATE.
179500
179500     BANDWIDTH ..................... 0 TO 35 MHZ
179500     SENSITIVITY ................... 10 MV RMS
179500     TIME BASE ..................... 100KHZ TO 10 MHZ
179500
   GENERAL RADIO               #1191-B              $1495        111
       FREQUENCY ......................... DC TO 35 MHZ
       COUNTING GATE TIMES ............... 1 MICROSEC TO 10 SEC
       ACCURACY .......................... +/- 1 COUNT +/- TIME-BASE ACCUR
       SENSITIVITY ....................... 10 MV RMS SINE WAVE, 30 MV P-P
                                           PULSE DECREASING ABOVE 20 MHZ
                                           TO APPROX 100 MV RMS AT 30 MHZ
       DISPLAY ........................... 8 DIGITS

   HEWLETT PACKARD             #5323A               $1650        111

   JOHN FLUKE MFG CO INC       #1952A               $695         111
       FREQUENCY RANGE ................... DC TO 80 MHZ
       DISPLAY ........................... 7 DIGIT LED (8 OR 9 OPTIONAL)
       SENSITIVITY ....................... 50 MV RMS DC TO 50 MHZ INCREAS-
                                           ING TO 75 MV AT 80 MHZ
       PERIOD RANGE ...................... DC TO 10 MHZ (DC COUPLED)
                                           5 HZ TO 10 MHZ (AC COUPLED)
       TIME INTERVAL RANGE ............... 0.1 MICROSEC TO 1E+6 SEC

104020 AUTOMATIC DISPLAY GENERATOR                             AP809   11111
104020
104020 PROVIDES 3D DISPLAY
   OPTICS TECHNOLOGY INC       #215                 $1995        111
       POWER LEVEL........................ 0.3 TO 1.0MW;   1.0 TO 2.0MW
       EXPOSURE TIME                       45 TO 180 SEC;  15 TO 60 SEC
       MOUNT.............................. BENCH
       FILM PLATE SIZE.................... 4 X 5IN
       HOLOGRAM TYPES..................... GABOR AND FRESNEL

   JODON ENGR ASSOC            #HS-2                $8700
       ACTIVE VIBRATION ISOLATION
       LASER.............................. 20MW HE NE
       SYSTEM COMPONENTS.................. REAL TIME PLATE HOLDER, SHUTTER
                                           BEAM STEERER, REFERENCE MIRRORS
                                           SPATIAL FILTERS, VARIABLE BEAM
                                           SPLITTER, ENCLOSURE

   JODON ENGR ASSOC            #AP-10C AUTO         $6500
                                 PHOTO PROCESSOR
       PROVIDES CHEMICAL FILLING AND CIRCULATING, AND DRAINING TO
       PROCESS PHOTOGRAPHIC PLATE

104020
055050 CAMERA STILL                                            AP810   11111
055050
055050 RECORD EXPERIMENT PHENOMENA
055050
055050     FILM SIZE...................... 35MM
055050     SHUTTER SPEED.................. 1 SEC TO 1/500 SEC
055050
   HONEYWELL INC               #SPOTOMATIC F +7191  $639         111
       LENS .............................. 55 MM, F/1.8 TAKUMAR
                                           35 MM, F/2.0 TO F/16 TAKUMAR
       SHUTTER SPEEDS ........................ 1/1000 SEC TO TIME
       VIEWING ........................... THRU LENS
       FILM SIZE ......................... 35 MM

430000 X-Y RECORDER                                            AP811   21111
430000
430000 REAL-TIME ACCURATE REPRODUCTION OF SPECTRAL DATA SOURCES PLOTTED
430000 ON CARTESIAN COORDINATES.
430000
430000     CHANNELS ...................... 1
430000     ACCURACY ...................... +/- 0.2 % FS
430000
   ROHDE AND SCHWARZ           #ZSK (100.1950.02)  $10500        111
       WRITING SPEED ..................... 1.50 M/SEC
       DEFLECTION FACTOR ................. 10 MICROVOLT/CM TO 10 V/CM
       WRITING METHOD .................... ELECTRIC PEN

   HEWLETT PACKARD             #7035B               $985         111
       INPUT RANGE ....................... 1, 10, 100 MV/IN; 1 AND 10 V/IN
       WRITING METHOD .................... ELECTRIC PEN
       ACCURACY .......................... +/- 0.2 % FS
       LINEARITY ......................... +/- 0.1 % FS

425500 RECORDER - STRIP CHART                                  AP812   21111
425500
425500 RECORD HARD COPY DATA FROM LOW FREQUENCY ANALOG INVESTIGATIONS
425500
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                              ............ DC TO 150 HZ
425[illegible]    CHANNELS ........................ EVENT, TIME, [illegible] DATA
                  ........................ +/- 0.5 PCT
425500
    BECKMAN INSTRUMENTS           #RP                   $3823            111
        FREQUENCY ........................ DC TO 130 HZ
        CHANNELS ......................... EVENT,TIME,2-DATA
        WRITING METHOD ................... THERMAL
        SENSITIVITY ...................... 1MUV/MM TO 5V/MM
        RESPONSE TIME .................... 5MSEC FOR 10-90% OF 50MM PEN TR
        CHART SPEED ...................... 1 TO 250 MM/SEC
        IRIG OUTPUT ...................... OPTIONAL

    HONEYWELL                     #1508                 $330[illegible]  111
        DATA CHANNELS..................... 24
        EVENT CHANNELS.................... 4
        FREQUENCY RESPONCE................ DC TO 25KHZ
        PAPER SPEED....................... 0.1 TO 120 IPS
        MOUNT............................. RACK
        PAPER WIDTH....................... 8IN

    HONEYWELL                     #1856                 1
        RESOLUTION ....................... 200 ELEMENTS/INCH (1000/SWEEP)
        RECORDING RATE ................... PE+06 BITS/SEC
        CRT .............................. FIBER OPTICS
        SPOT SIZE ........................ 0.005 INCH
        SWEEP SPEED ...................... 20,000 LINES/SEC

    HONEYWELL                     #1858                 $
        SIZE-RACK MOUNTED ................ 8.75H X 19.16 X 21D
        WEIGHT (W/O ACCESSORIES) ......... 65 LBS.
        ACCESSORIES ...................... 6 LBS.
        CHANNELS ......................... 18
        RECORDING STYLUS ................. INERTIALESS-NO MOVING ELEMENT
        RESPONSE ......................... DC TO 5000 HZ
        INPUT SENSITIVITY ................ 100 MICROVOLT - 300 VOLTS
        ACCURACY ......................... 0.1 %
        PAPER SPEED ...................... 0.1 TO 120 IPS
        POWER ............................ 120/240 V. 50-400 HZ

    HEWLETT PACKARD               #7100BR WITH OPTION   $2295            111
                                   019 AND 023.
                                   17500A PLUG-IN
        CHANNELS ......................... 2 CHANNELS PLUS EVENT MARKER ON
                                           BOTH SIDES
        WRITING METHOD ................... ELECTRIC
        ACCURACY ......................... +/- 0.2 % FS
        VOLTAGE SPAN ..................... 5 MV TO 100 V

    HEWLETT PACKARD               #7702B/8801A          $2750            111
        FREQUENCY RESPONSE ............... DC TO 125 HZ
        WRITING METHOD ................... THERMAL
        SENSITIVITY ...................... 5 MV/DIV
        CHANNELS ......................... 2 CHANNELS TIMER/MARKER
        VOLTAGE RANGE .................... 5 MV TO 5 V PER DIV
        ACCURACY ......................... +/- 1 %

    HEWLETT PACKARD               #7708/8802A           $8975
        CONFIGURATION .................... RACK MOUNTED
        CHART SPEED ...................... 0.25, 0.5, 1, 2.5, 5, 10, 25,
                                           50, 100 MM/SEC
        FREQUENCY RESPONSE ............... 150 HZ
        CHANNELS ......................... 8
        WRITING METHOD ................... THERMAL
        INPUT RANGES ..................... 1, 2, 5, 10, 20, 50, 100, 200,
                                           500, 1000 MV/DIV
        ACCURACY ......................... +/- 1%

    HONEYWELL                     #1912                 $7700            111
        PAPER WIDTH....................... 12IN
        CHANNELS.......................... 24
        FREQUENCY RESPONCE................ DC TO 25KHZ
        PAPER SPEED....................... 200IPS
        SPEED VARIATION................... 15 FORWARD, 12 REVERSE SPEEDS
        MOUNT............................. RACK

    BECKMAN INSTRUMENTS           #R                    $10759           111
        BANDWIDTH......................... DC TO 130HZ
                  ........................ 5000 HZ WITH PR-500TAPE REC
        CHANNELS ......................... 1 TO 8 UP TO 24 SPEC ORDER
        REC FORMAT ....................... THERMAL RECTILINEAR
        CHART SPEED ...................... 0.1 TO 25 CM/SEC OTHERS AVAIL
        EVENT MARKERS ....................  2 (OPTION)
        DIMENSIONS .......................  69.5X21.5X22.5 INCHES
        POWER ............................  120V 50/60 HZ 250W

425900 RECORDER - STRIP CHART                                  AP813   21111
425900
425900 RECORD HARD COPY DATA.
425900
425900    CHANNELS........................ 2
425900
    BECKMAN INSTRUMENTS           #RP                   $3920            111
        FREQUENCY ........................ DC TO 130 HZ
        CHANNELS ......................... EVENT, TIME, 2 DATA
        WRITING METHOD ................... THERMAL
        SENSITIVITY ...................... 1 MUV/MM TO 5 V/MM
        RESPONSE TIME .................... 5 MSEC FOR 10-90% OF 50 MM PEN
                                           TR
        CHART SPEED ...................... 1 TO 250 MM/SEC
        IRIG OUTPUT ...................... OPTIONAL
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HEWLETT PACKARD             #7100BR WITH OPTION  $2295          111
                             019 AND 023.
                             17500A PLUG-IN
     CHANNELS ........................ 2 CHANNELS PLUS EVENT MARKER ON
                                       BOTH SIDES
     WRITING METHOD .................. ELECTRIC
     ACCURACY ........................ +/- 0.2 % FS
     VOLTAGE SPAN .................... 5 MV TO 100 V

HEWLETT PACKARD             #7702B/8801A         $2750          111
     FREQUENCY RESPONSE .............. DC TO 125 HZ
     WRITING METHOD .................. THERMAL
     SENSITIVITY ..................... 5 MV/DIV
     CHANNELS ........................ 2 CHANNELS TIMER/MARKER
     VOLTAGE RANGE ................... 5 MV TO 5 V PER DIV
     ACCURACY ........................ +/- 1 %

HONEYWELL                   #1508B               $3300          111
     DATA CHANNELS.................... 24
     EVENT CHANNELS................... 4
     FREQUENCY RESPONCE............... DC TO 25KHZ
     PAPER   SPEED.................... 0.1 TO 120 IPS
     MOUNT............................ RACK
     PAPER WIDTH...................... 8IN

HEWLETT PACKARD             #7708B/8802A         $8975
     CONFIGURATION ................... RACK MOUNTED
     CHART SPEED ..................... 0.25, 0.5, 1, 2.5, 5, 10, 25,
                                       50, 100 MM/SEC
     FREQUENCY RESPONSE .............. 150 HZ
     CHANNELS ........................ 8
     WRITING METHOD .................. THERMAL
     INPUT RANGES .................... 1, 2, 5, 10, 20, 50, 100, 200,
                                       500, 1000 MV/DIV
     ACCURACY ........................ +/- 1%

HONEYWELL                   #1856                $
     RESOLUTION ...................... 200 ELEMENTS/INCH (1000/SWEEP)
     RECORDING RATE .................. 8E+06 BITS/SEC
     CRT ............................. FIBER OPTICS
     SPOT SIZE ....................... 0.005 INCH
     SWEEP SPEED ..................... 20,000 LINES/SEC

HONEYWELL                   #1858                $
     SIZE-RACK MOUNTED ............... 8.75H X 19.1W X 21D
     WEIGHT (W/O ACCESSORIES) ........ 65 LBS.
     ACCESSORIES ..................... 6 LBS.
     CHANNELS ........................ 18
     RECORDING STYLIS ................ INERTIALESS-NO MOVING ELEMENT
     RESPONSE ........................ DC TO 5000 HZ
     INPUT SENSITIVITY ............... 100 MICROVOLT - 300 VOLTS
     ACCURACY ........................ 0.1 %
     PAPER SPEED ..................... 0.1 TO 120 IPS
     POWER ........................... 120/240 V, 50-400 HZ

HONEYWELL                   #1912                $7700          111
     PAPER WIDTH...................... 12IN
     CHANNELS......................... 24
     FREQUENCY RESPONCE............... DC TO 25KHZ
     PAPER SPEED...................... 200IPS
     SPEED VARIATION.................. 15 FORWARD, 12 REVERSE SPEEDS
     MOUNT............................ RACK

BECKMAN INSTRUMENTS         #R                   $10759         111
     BANDWIDTH........................ DC TO 130HZ
               ....................... 5000 HZ WITH PR-500TAPE REC
     CHANNELS ........................ 1 TO 8 UP TO 24 SPEC ORDER
     REC FORMAT ...................... THERMAL RECTILINEAR
     CHART SPEED ..................... 0.1 TO 25 CM/SEC OTHERS AVAIL
     EVENT MARKERS ...................  2 (OPTION)
     DIMENSIONS ......................  69.5X21.5X22.5 INCHES
     POWER ...........................  120V 50/60 HZ 250W

424000 TAPE RECORDER - ANALOG                           AP814   11111
424000
424000 RECORD AND PLAYBACK OF ANALOG DATA IN SUPPORT OF ATMOSPHERIC AND
424000 SPACE PLASMA PHYSICS SORTIE LABORATORY INVESTIGATIONS.
424000
424000    BANDWIDTH ...................... 2 MHZ
424000    CHANNELS ....................... 14
424000    RECORDING FORMAT ............... FM
424000
  AMPEX CORPORATION           #AR-200                           121
     BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                       300 HZ TO 250 KHZ
     TAPE WIDTH ...................... 0.5 INCH
     TAPE SPEED ...................... 1.875 TO 60 IPS
     RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
     FORMAT .......................... DIGITAL
     TRACKS .......................... 8 DIGITAL, 7 ANALOG

  HEWLETT PACKARD             #7970B/C             $ 4600         111
     TAPE FORMAT ..................... 800, 556, OR 200 CPI NRZI AND
                                       1600 CPI PHASE-ENCODED
     CHANNELS ........................ 7 OR 9
     TAPE SPEED ...................... 10 TO 45 IPS
     TAPE ............................ 0.5 INCH, 1.5 MILS, IBM/ANSI
                                       COMPATIBLE
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DIGI-DATA CORPORATION          #1700/PDP-11/7-9     $5250          111
                                TRACK NRZI
    TAPE SPEED ......................... 45, 37.5, 25, 18.75, 12.5 IPS
    TAPE ............................... 0.5 INCH, 1.5 MIL, IBM/ANSI
                                         COMPATIBLE, 10.5 INCH REEL
    TRACKS ............................. 7 OR 9
    DATA DENSITY ....................... PHASE ENCODED

BORG WARNER                    #PERT                               121
    TRACKS ............................. 30
    SIGNAL/NOISE........................24 DB
    TAPE SPEED ......................... UP TO 1000 IPS
    TAPE WIDTH ......................... 1/2 INCH
    TAPE LENGTH ........................ 2400 FEET
    PACKING DENSITY .................... 15 KB/I/T
    DATA CAPACITY ...................... 1.3E+9
    BANDWIDTH .......................... 5-15 MB/SEC/T

ERAD                           #MTR 7000                           311
    TRACKS ............................. 12
    TAPE SPEED ......................... 120 IPS
    TAPE WIDTH ......................... 1 INCH
    TAPE LENGTH......................... 9200 FEET
    PACKING DENSITY..................... 16.7 KB/I/T
    SIGNAL/NOISE ....................... 22 DB
    DATA CAPACITY ...................... 2.2E+10
    BANDWIDTH .......................... 2 MB/SEC/T

SANGAMO ELECTRIC               #SABER III           $26,500        111
    TRACKS ............................. 14
    TAPE WIDTH ......................... 1 INCH
    TAPE SPEED ......................... 8 SELECTABLE SPEEDS FROM 15/16
                                         TO 120 IPS
    FREQUENCY RESPONSE ................. 400 HZ TO 2.0 MHZ
    RECORDING RATE ..................... 600 KBPS AT 120 IPS SERIAL MODE
    WEIGHT ............................. 100 POUNDS

HEWLETT PACKARD                #3955D               $10200         111
    BANDWIDTH .......................... 300 KHZ
    CHANNELS ........................... 7
    RECORDING FORMAT ................... DIRECT OR FM

HEWLETT PACKARD                #3955C               $14700         111
    BANDWIDTH .......................... 300 KHZ
    CHANNELS ........................... 14
    RECORDING FORMAT ................... DIRECT OR FM

HEWLETT PACKARD                #3950A-011           $23900         111
    BANDWIDTH .......................... 500 HZ TO 2 MHZ
    CHANNELS ........................... 14
    RECORDING FORMAT ................... DIRECT OR FM

HEWLETT PACKARD                #3960A/13065A/13063A $6796          111
    CONFIGURATION ...................... RACK MOUNTED
    TAPE SPEED ......................... 15, 3 AND 3/4, 15/16 IPS
    CHANNELS ........................... 4
    RECORDING FORMAT ................... FM
    PASSBAND ........................... 5 KHZ
    S/N RATIO........................... 40 DB
    TRACKS ............................. 30

HONEYWELL                      #5600                $9730
    PORTABLE TAPE RECORDER
    CHANNELS............................ 7
    SELECTABLE TAPE SPEED RANGE......... 15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)........... 300KHZ
    PACKING DENSITY..................... UP TO 600PBI
    WEIGHT.............................. 70LBS (32KG)
    INPUT VOLTAGE.......................28VDC

HONEYWELL                      #96                  $17420
    CHANNELS............................ 7
    SELECTABLE TAPE SPEED RANGE......... 15/16 TO 240IPS
    REEL SIZE........................... 16IN
    MAXIMUM BANDWIDTH(DIRECT)........... 2M HZ
    TAPE WIDTH.......................... 1/2 IN

DIGI-DATA CORPORATION          #1600                $2650          111
    TAPE SPEED ......................... 25, 18.75, 12.5 IPS
    TRACKS ............................. 7 OR 9 TRACK
    DATA DENSITY ....................... 1600 CPI PHASE ENCODED
                                         200, 556, 800 CPI NRZI
    TAPE ............................... 0.5 INCH, 1.5 MIL, 1200 FEET

AMPEX CORP                     #AR 700              $29,180        511
    TRACKS ............................. 14
    TAPE SPEED ......................... 60 IPS
    TAPE WIDTH ......................... 1 INCH
    RECORD MODE......................... DIRECT
    PACKING DENSITY .................... 20 KB/I/T
    SIGNAL/NOISE ....................... 20 DB
    DATA CAPACITY ...................... 9E+10 BITS
    BANDWIDTH .......................... 1 MB/SEC/T

398500 OSCILLOSCOPE                                       AP815   21111
398900
       MONITOR MEASURE AND MAINTAIN OPERATING ELECTRONIC EQUIPMENT
398900
398900    BANDWIDTH ....................... 500 MHZ
398900    CHANNELS ........................ 2
398900    DEFLECTION FACTOR ............... 2 MV
398900    PHOTOGRAPHIC CAPABILITY ......... YES
398900
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      HEWLETT-PACKARD                  #132A                $1500          111
           BANDWIDTH ...................... DC TO 500KHZ
           SENSITIVITY .................... 100 MICROVOLTS/CM
           INDEPENDENT BEAMS .............. 2
           WEIGHT ......... ............... 43 POUNDS

      TEKTRONIX INC                    #7904/7A19 PLUG-IN   $6050          111
                                        /7870 PLUG-IN
           BANDWIDTH ...................... DC TO 500 MHZ
           CHANNELS ....................... 2
           DEFLECTION FACTOR .............. 10 MV/DIV TO 1 V/DIV
           TIMEBASE ....................... 2 NS/DIV TO 5 S/DIV

      HEWLETT/PACKARD                  #AN/USM-281A         $3100          111
           MEETS MIL-SPEC REQUIREMENTS
           BANDWIDTH....................... DC TO 5MHZ
           SENSITIVITY..................... 0.1V/DIV TO 1.0V/DIV
           CHANNELS........................ 2

      HEWLETT PACKARD                  #1800/1811A          $2750          111
           BANDWIDTH ...................... 4 OR 18 GHZ
           DEFLECTION FACTOR .............. 2 MV
           CHANNELS ....................... 2
           PHOTOGRAPHIC CAPABILITY ........ YES

      TEKTRONIX                        #485                 $4200          111
           RANGE,CALIBRATED...............  5MV/DIV TO 5V/DIV IN 10 STEPS
                 UNCALIBRATED.............. CONT VAR TO 12.5V/DIV
           CHANNELS........................ 1,ALTERNATE, CHOPPED,ADDED,X-Y
                ........................... CHANNEL 2 (+UP OR INVERTED)
           DIMENSIONS...................... 16.7 X 52.4 X 30.5 CM
           WEIGHT.......................... 9.5 KG
           POWER........................... 115/230V 48-440HZ  60W
           RESPONSE TIME...................< 1NS
           BANDWIDTH.......................350MHZ

      TEKTRONIX INC                    #R465                $1800          111
           BANDWIDTH ...................... DC TO 100 MHZ
           CHANNELS ....................... 2
           DEFLECTION FACTOR .............. 5 MV/DIV TO 5 V/DIV
           TIME BASE ...................... 0.01 MICROSEC/DIV TO 0.5 S/DIV

      TEKTRONIX INC                    #R561B/3A6 PLUG-IN/  $1840          111
                                        3B4 PLUG-IN

           BANDWIDTH ...................... DC TO 10 MHZ
           CHANNELS ....................... 2
           DEFLECTION FACTOR .............. 10 MV/DIV TO 10 V/DIV
           TIME BASE ...................... 50 NS/DIV TO 5 S/DIV
           RISETIME ....................... 35 NS

055050 CAMERA,STILL                                            AP816    21111
055050
055050 POLAROID CAMERA TO RECORD TRACES ON OSCILLOSCOPE
055050
055050     FILM FORMAT..................... POLAROID 107 BLACK/WHITE
055050                                      3.25X4.25IN(92.55X192.95MM)
055050     LENS............................ 56MM  F3.5 TO F22
055050     SHUTTER SPEEDS.................. B TO 1/60 SEC
055050     FIELD OF VIEW................... 40 DEGREES
055050
      TEKTRONIX INC                    #C-12                $590           111
           LENS ........................... 75 MM
           STOP ........................... F/1.9 TO F/16
           MAGNIFICATION .................. 0.85
           LENS SPEED ..................... 1 TO 1/100 SEC MECH
                                            4 TO 1/60 SEC ELECT
           FILM TYPE....................... POLAROID

      TEKTRONIX                        #C30                 $525
           MAXIMUM RELATIVE APERTURE....... F/1.9
           MAGNIFICATION................... 0.7 TO 1.5
           RELATIVE SPEED.................. 1.0
           FIELD OF VIEW................... 3.15X3.93IN (8X10CM)
           FILM TYPE....................... POLAROID

      HEWLETT-PACKARD                  #198                 $420
           MAXIMUM RELATIVE APERTURE....... F/3.5
           MAGNIFICATION................... 1:0.85
           SPEED........................... B TO 1/60 SEC
           LENS............................ 75MM
           FILM TYPE....................... POLAROID

      HEWLETT-PACKARD                  #195A                $1025
           MAXIMUM RELATIVE APERTURE....... F/1.3
           MAGNIFICATION................... 1:0.5
           SPEED........................... B TO 1/30 SEC
           LENS............................ 80MM
           FILM TYPE....................... POLAROID

424000 TAPE RECORDER - DIGITAL                                 APP17    21111
424000
424000 RECORDING AND PLAYBACK OF DIGITAL DATA COMPATABLE WITH ANY ON-
424000 BOARD COMPUTING EQUIPMENT.
424000
424000     BANDWITH ....................... 2 MHZ
424000     CHANNELS ....................... 8
424000     SIGNAL ......................... 0 TO 5 VDC DIGITAL
424000
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AMPEX CORPORATION             #AR-200                                121
     BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                       300 HZ TO .50 KHZ
     TAPE WIDTH ...................... 0.5 INCH
     TAPE SPEED ...................... 1.875 TO 60 IPS
     RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
     FORMAT .......................... DIGITAL
     TRACKS .......................... 8 DIGITAL, 7 ANALOG

DIGI-DATA CORPORATION         #1700/PDP-11/7-9     $5250            111
                               TRACK NRZI
     TAPE SPEED ...................... 45, 37.5, 25, 18.75, 12.5 IPS
     TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                       COMPATIBLE, 10.5 INCH REEL
     TRACKS .......................... 7 OR 9 TRACK
     DATA DENSITY .................... PHASE ENCODED

AMPEX CORP                    #AR 1700             $[illegible]     [illegible]
     TRACKS .......................... 14
     TAPE SPEED ...................... 120 IPS
     TAPE WIDTH ...................... 1 INCH
     RECORDING MODE................... DIRECT
     PACKING DENSITY ................. 20 KB/I/T
     SIGNAL/NOISE .................... 20 DB
     DATA CAPACITY ................... 6.2E+10
     BANDWIDTH ....................... 2 MB/SEC/T
     TAPE LENGTH......................9200 FEET

SANGAMO ELECTRIC              #SABRE III           $26,500          111
     TRACKS .......................... 14
     TAPE WIDTH ...................... 1 INCH
     TAPE SPEEDS ..................... 8 SELECTABLE SPEEDS FROM 15/16
                                       TO 120 IPS
     FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
     RECORDING RATE .................. 600 KBPS AT 120 IPS SERIAL MODE
     WEIGHT .......................... 150 POUNDS
HEWLETT PACKARD               #7970B/C             $ 4600           111
     TAPE FORMAT ..................... 800, 556, OR 200 CPI NRZI AND
                                       1600 CPI PHASE-ENCODED
     CHANNELS ........................ 7 OR 9
     TAPE SPEED ...................... 10 TO 45 IPS
     TAPE ............................ 0.5 INCH, 1.5 MILS, IBM/ANSI
                                       COMPATIBLE

BORG WARNER                   #HERT                                 121
     TRACKS .......................... 30
     TAPE SPEED ...................... UP TO 1000 IPS
     TAPE WIDTH ...................... 1/2 INCH
     TAPE LENGTH ..................... 2400 FEET
     PACKING DENSITY ................. 15 KB/I/T
     SIGNAL/NOISE .................... 24 DB
     DATA CAPACITY ................... 1.3E+9
     BANDWIDTH ....................... 6-15 MB/SEC/T

LEACH                         #MTR 7000                             311
     TRACKS .......................... 12
     TAPE SPEED ...................... 120 IPS
     TAPE WIDTH ...................... 1 INCH
     TAPE LENGTH...................... 9200 FEET
     PACKING DENSITY.................. 16.7 KB/I/T
     SIGNAL/NOISE .................... 22 DB
     DATA CAPACITY ................... 2.2E+10
     BANDWIDTH ....................... 2 MB/SEC/T

HEWLETT PACKARD               #3955D               $10200           111
     BANDWIDTH ....................... 300 KHZ
     CHANNELS ........................ 7
     RECORDING FORMAT ................ DIRECT OR FM

HEWLETT PACKARD               #3955C               $14700           111
     BANDWIDTH ....................... 300 KHZ
     CHANNELS ........................ 14
     RECORDING FORMAT ................ DIRECT OR FM

HEWLETT PACKARD               #3950A-011           $23800           111
     BANDWIDTH ....................... 500 HZ TO 2 MHZ
     CHANNELS ........................ 14
     RECORDING FORMAT ................ DIRECT OR FM
HEWLETT PACKARD               #3960A/13065A/13063A $4796            111
     CONFIGURATION ................... RACK MOUNTED
     TAPE SPEED ...................... 15, 3 AND 3/4, 15/16 IPS
     CHANNELS ........................ 4
     RECORDING FORMAT ................ FM
     PASSBAND ........................ 5 KHZ
     S/N RATIO........................ 48 DB
     TRACKS .......................... 30

HONEYWELL                     #5600                $9730
     PORTABLE TAPE RECORDER
     CHANNELS......................... 7
     SELECTABLE TAPE SPEED RANGE...... 15/16 TO 60IPS
     MAXIMUM BANDWIDTH(DIRECT)........ 300KHZ
     PACKING DENSITY.................. UP TO 600PBI
     WEIGHT........................... 70LBS (32KG)
     INPUT VOLTAGE....................28VDC

HONEYWELL                     #96                  $17420
     CHANNELS......................... 7
     SELECTABLE TAPE SPEED RANGE...... 15/16 TO 240IPS
     REEL SIZE........................ 16IN
     MAXIMUM BANDWIDTH(DIRECT)........ 2M HZ
     TAPE WIDTH....................... 1/2 IN
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    DIGI-DATA CORPORATION          #1600                $2650          111
         TAPE SPEED ....................... 25, 18.75, 12.5 IPS
         TRACKS ........................... 7 OR 9 TRACK
         DATA DENSITY ..................... 1600 CPI PHASE ENCODED
                                            200, 556, 800 CPI NRZI
         TAPE ............................. 0.5 INCH, 1.5 MIL, 1200 FEET

    APPEX CORP                     #AP 700              $29,180        511
         TRACKS ........................... 14
         TAPE SPEED ....................... 60 IPS
         TAPE WIDTH ....................... 1 INCH
         RECORD MODE....................... DIRECT
         PACKING DENSITY .................. 20 KB/I/T
         SIGNAL/NOISE ..................... 20 DB
         DATA CAPACITY .................... 8E+10 BITS
         BANDWIDTH ........................ 1 MB/SEC/T

102700 COMPUTER                                                APB18   21111
102700
102700 COMPUTER CAPABILITY TO  SUPPORT ATMOSPHERIC AND SPACE PLASMA
102700 PHYSICS INVESTIGATIONS.
102700
102700     WORD SIZE ...................... 16 BIT
102700     IP/OP MEMORY TRANSFER........... 1E+06--16 BIT WORDS/SEC
102700     CORE MEMORY .................... 32E+03 WORDS
102700     IP/OP CHANNELS ................. 45
102700
    DATA GENERAL CORP              #NOVA 800            $18450         111
         WORD LENGTH ...................... 16 BIT
         CYCLE TIME ....................... 800 NANOSEC.
         CORE MEMORY ...................... 32K MAX

    DATA GENERAL CORP              #SUPERNOVA SC        $5600          111
         WORD LENGTH ...................... 16 BIT

    VARIAN DATA MACHINES           #520/I                              111
         MEMORY CYCLE TIME ................ 1.5MICROSEC.
         MEMORY ........................... EXPANDABLE,4096BYTES(8BITS)TO
                                            32,768BYTES
         REGISTERS ........................ 12
         OPERAND PRECISION ................ UP TO 32 BITS
         ADDRESS REFERENCE ................ 8,16,24,OR 32 BIT LEVEL
         NOTE:                              HAS FULL RANGE INTERFACE
                                            HARDWARE

    VARIAN DATA MACHINES           #R-620/I                            111
         BASIC COMMANDS  .................. OVER 100
         ADDRESSING MODES  ................ 6
         MAX.WORDS  ....................... 32,768
         WORD LENGTH  ..................... 16 OR 18 BIT
         REGISTERS  ....................... 9
         NOTE:                              HAS FULL RANGE INTERFACE
                                            HARDWARE

    CLARY DATACOMP SYSTEMS INC     #404                                111
         SIMULTANEOUS TERMINALS ........... 16
         INPUT ............................ TELETYPEWRITER KEYBOARD
         ACCUMULATOR ...................... 64 BIT
         REGISTERS ........................ 16 BIT INDEX (2 EACH)
         WORD LENGTH ...................... 16, 32, 48, 64 BITS
         MEMORY CAPACITY .................. 1024 16 BIT WORDS, 4096 16 BIT
                                            WORDS,OR ADDITIONAL 4096 16 BIT
                                            WORDS. TOTAL 65538 WORDS

    GENERAL AUTOMATION INC.        #18-30                              111
         FUNCTION ......................... SUPERVISE SMALLER COMPUTERS
         MEMORY............................ 8K CORE
         CYCLE TIME ....................... 1.2 MICROSEC.

    GENERAL AUTOMATION INC.        #SPC-16                             111
         MEMORY ........................... 16K
         WORD LENGTH ...................... 16 BITS
         READ/WRITE CYCLE MEMORY TIME ..... 800 TO 1440 NANOSEC.
         READ ONLY MEMORY ................. 400 TO 720 NANOSEC.
         INPUT/OUTPUT TIME ................ 1.6 TO 2.8 MICROSEC.
         DMA TRANSFER RATE ................ 0.694E+06 TO 2.5E+06

    GENERAL AUTOMATION INC.        #SPC-12                             111
         MEMORY ........................... 4K TO 16K
         WORD LENGTH ...................... 8 BITS
         CYCLE TIME ....................... 2.16 MICROSEC
         STORED PROGRAM EXECUTION RATE .... 0.23E+06/SEC
         I/O TRANSFER RATE ................ 0.46E+06/SEC
         REGISTERS ........................ 6 12 BIT REGISTERS
         ACCUMULATORS ..................... 4 12 BIT

    DATA GENERAL CORP              #NOVA 1200           $11900         111
         WORD LENGTH ...................... 16 BIT
         CYCLE TIME ....................... 1200 NANOSEC.
         CORE MEMORY ...................... 32K MAX.

    DIGITAL EQUIPMENT CORP         #PDP-8/E             $22000         111
         MEMORY ........................... 4096(CORE)EXPANDABLE TO
                                            32,768 WORDS
         WORD ............................. 12 BIT
         CYCLE TIME ....................... 1.5 MICROSEC.
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101340 KEYBOARD DISPLAY TERMINAL                                AP819   11111
101340
101340 GENERAL PURPOSE INPUT KEYBOARD ALLOWING FOR PROGRAMING, DATA
101340 INPUT AND UPDATE, AND DATA MANIPULATION FOR ONBOARD ANALYSIS
101340
    RESEARCH INC                        #DPS-812           $21,700          111
        COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
        DEC-PDP8-F MINI-COMPUTER, #3301 OPERATIONS CONTROL CONSOLE,
        PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
        CHANNELS ......................... 32
        MEMORY SIZE ...................... 8K WORDS

    RESEARCH INC                        #812-3301          $1555            111
        SCREEN FORMAT .................... 12 LINES X 72 OR 80 CHARACTERS,
                                           24 LINES X 40 CHARACTERS
        CHARACTER FORMAT ................. 5 X 7 DOT MATRIX
        TRANSFER RATE .................... 110 TO 2400 BAUD, 10 OR 11 BIT
                                           CHARACTERS
        MODES ............................ HALF OR FULL DUPLEX-SWITCHABLE
                                           LOCAL OR REMOTE

    HEWLETT PACKARD                     #2640A             $3580            111

    TEKTRONIC                           #4002A/021-00XX-00   $9550          111
        DISPLAY MEDIUM ................... 11 INCH DIRECT-VIEW, BISTABLE
                                           STORAGE CRT WITH REFRESHED
                                           SCRATCH PAD AREA
        DISPLAY AREA ..................... 8.3 INCHES HORIZONTAL X 6.1
                                           INCHES VERTICAL
        ALPHANUMERIC MODE
            FORMAT ....................... 39 LINES OF 85 NORMAL OR ITALIC
                                           CHARACTERS IN MAIN AREA, ONE
                                           LINE OF 84 CHARACTERS IN
                                           SCRATCH PAD AREA
            CHARACTER SET ................ 96 UPPER AND LOWER CASE PRINT-
                                           ING CHARACTERS (ASCII CODE)
            CHARACTER SIZE ............... 70X90 MILS (CAN BE DOUBLE SIZE)
            CHARACTER GENERATION ......... 7X9 DOT MATRIX
            CURSOR ....................... PULSATING 7X9 MATRIX
        GRAPHIC MODES .................... LINEAR INTERPOLATE, INCREMENTAL
                                           PLOT, POINT PLOT, 1024X1024
                                           ADDRESSABLE POINTS, 1024X761
                                           VIEWABLE POINTS
        GRAPHIC INPUT MODE ............... 1024 (X), 761 (Y) POINTS, JOY-
                                           STICK CONTROLLED, CROSS-HAIR
                                           CURSOR

104180 STATUS PANEL                                             AP820   21111
104180
104180 DISPLAY TERMINAL WITHOUT KEYBOARD PROVIDING STATUS OF EXPERIMENT
104180 FUNCTIONS
104180
    HEWLETT PACKARD                     #2640A             $3580            111

    TEKTRONIC                           #4002A/C21-00XX-00   $9550          111
        DISPLAY MEDIUM ................... 11 INCH DIRECT-VIEW, BISTABLE
                                           STORAGE CRT WITH REFRESHED
                                           SCRATCH PAD AREA
        DISPLAY AREA ..................... 8.3 INCHES HORIZONTAL X 6.1
                                           INCHES VERTICAL
        ALPHANUMERIC MODE
            FORMAT ....................... 39 LINES OF 85 NORMAL OR ITALIC
                                           CHARACTERS IN MAIN AREA, ONE
                                           LINE OF 84 CHARACTERS IN
                                           SCRATCH PAD AREA
            CHARACTER SET ................ 96 UPPER AND LOWER CASE PRINT-
                                           ING CHARACTERS (ASCII CODE)
            CHARACTER SIZE ............... 70X90 MILS (CAN BE DOUBLE SIZE)
            CHARACTER GENERATION ......... 7X9 DOT MATRIX
            CURSOR ....................... PULSATING 7X9 MATRIX
        GRAPHIC MODES .................... LINEAR INTERPOLATE, INCREMENTAL
                                           PLOT, POINT PLOT, 1024X1024
                                           ADDRESSABLE POINTS, 1024X761
                                           VIEWABLE POINTS
        GRAPHIC INPUT MODE ............... 1024 (X), 761 (Y) POINTS, JOY-
                                           STICK CONTROLLED, CROSS-HAIR
                                           CURSOR

104180 SPECIAL DATA ACQUISITION PANEL                           APP21   11124
104180
603002 BATTERY CONTROL AND MONITOR                              AP827   11114
603002
095055 CAMERA - CINE                                            AP829   11111
095055
    J A MAURER INC                      #317-E1            $4500            311
        MODES ............................ 8, 16, 32, 64 FPS ELECT CONT
        SHUTTER .......................... ROTARY
        SHUTTER SPEEDS ................... 1/62.5 TO 1/500 SEC
        FILM ............................. 16 MM MAGAZINE
        LENS ............................. 25 MM, F/1.4
        RESOLUTION ....................... 234 L/MM ON AXIS, 150 L/MM AWAR
        FILM CAPACITY .................... 150 FT THIN BASE
    CINEMA BEAULIEU CORP                #R-16B             $3000            112
        CONFIGURATION .................... BENCH/LOOSE EQUIP
        OPERATION MODE ................... VARIABLE FRAME RATE OR SINGLE
                                           FRAME PULSE OPERATION UNDER
                                           REMOTE CONTROL
        SPEED ............................ 2 TO 64 FRAMES/SEC (VARIABLE)
        FILM SIZE ........................ 16 MM
        LENS ............................. C MOUNT LENS SYSTEM
        FILM CAPACITY .................... VARIOUS FILM MAGAZINES
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498500 TIME CODE GENERATOR AND DISPLAY                          AP832   11111
498500
498500 ACCURATE FREQUENCY, TIME INTERVAL AND TIME KEEPING CAPABILITIES.
498500
498500    OUTPUTS........................ 100 KHZ, 1 MHZ, 5 MHZ
498500    ACCURACY ...................... 5E-10 PARTS PER DAY
498500
    CATATRON                     #2150              $3220
         SERIAL CODE CAPABILITY.......... UP TO 5
         PULSE RATES..................... 1000,100,10 AND 1 PPS
         ACCURACY........................ 50 MICROSECS PER DAY

    DATATRON                     #3030              $7940              111
         CHANNELS........................ 32
         TIMING RANGE.................... 5 NANOSECS TO 5 MICROSECS
         ACCURACY........................ 5E-7 PARTS PER DAY

    DATATRON                     #3350              $1020              111
         INPUT FREQUENCY................. 60HZ
         OUTPUTS......................... VISUAL, BCD
         DISPLAY......................... HRS,MIN, SEC

603002 REMOTE SENSING PLATFORM GIMBAL CONTROL                   AP833   11134
603002
603002 XUV NORMAL INCIDENCE SPECTROMETER CONTROL                AP834   11114
603002
603002 UV-VIS-NIR SCANNING SPECTROMETER CONTROL                 AP835   11114
603002
603002 HIGH RESOLUTION FOURIER SWIR SPECTROMETER CONTROL        AP836   11114
603002
603002 CRYOGENIC IR FOURIER SPECTROMETER CONTROL                AP837   11114
603002
603002 IR RADIOMETER CONTROL                                    AP838   11114
603002
603002 FABRE-PEROT INTERFEROMETER CONTROL                       AP839   11114
603002
603002 UV,VIS DOCUMENTATION CAMERA CONTROL                      AP840   11114
603002
603002 ELECTROSTATIC ANALYZER CONTROL                           AP841   11134
603002
603002 MAGNETIC ANALYZER CONTROL                                AP842   11134
603002
603002 KEV-MEV PARTICLE DETECTOR CONTROL                        AP843   11134
603002
603002 TOTAL ENERGY DETECTOR CONTROL                            AP844   11134
603002
623010 LIDAR AND GIMBAL PLATFORM MONITOR                        AP845   11134
623010
620021 TRANSMITTER - 0.2 TO 2.0 MHZ                             AP901   11111
620021
620021 VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.
620021
620021    FREQUENCY BANDWIDTH ........... 0.2 TO 2.0 MHZ
620021    TRANSMITTER POWER ............. 10 KW
620021
    AYDIN CORP/VECTOR DIV        #T-102-TV          $3680              121
         TYPE ........................... UHF VIDEO TRANSMITTER
         FREQUENCY RESPONSE ............. 10 HZ TO 6 MHZ +/- 1.5 DB
         DEVIATION SENSITIVITY .......... +/- 6 MHZ/VOLT RMS
         RF POWER OUTPUT ................ 2 WATTS (50 OHM LOAD)

620020 TRANSMITTER - 2.0 TO 20.0 MHZ                            AP902   11111
620020
620020 VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.
620020
620020    FREQUENCY BANDWIDTH ........... 2.0 TO 20.0 MHZ
620020    TRANSMITTER POWER ............. 10 KW
620020
620050 TRANSMITTER - 0.3 TO 200 KHZ                             AP903   11111
620050
620050 VARIABLE RADIO FREQUENCY GENERATION AND TRANSMISSION.
620050
620050    FREQUENCY BANDWIDTH ........... 0.3 TO 200.0 KHZ
620050    TRANSMITTER POWER ............. 1.0 KW
620050
    AYDIN CO.                    T1C8S              $6100              121
         WATTS                              8(S BAND)
         POWER OUTPUT                       8WATTS(MIN.)W/50 OHM LOAD
         MODULATION TYPE                    FM
         FREQ.RESPONSE                      DC TO 500KHZ +/-1.5DB

    AYDIN CORP. VECTOR DIV.      T-102-TV           $3680              121
         TYPE                               UHF VIDEO TRANSMITTER
         FREQ. RESPONSE                     10HZ TO 6MHZ +/-1.5DB
         DEVIATION SENSITIVITY              +/-6MHZ/VOLT RMS
         RF POWER OUTPUT                    2 WATTS(50 OHM LOAD)

620022 ELECTROSTATIC WAVE TRANSMITTER                           AP904   11134
620022
219900 COUPLER - ANTENNA (0.2 TO 2.0 MHZ)                       AP909   11111
219900
219900 ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.
219900
219900    FREQUENCY BANDWIDTH ........... 0.2 TO 2.0 MHZ
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219900
219900 COUPLER - ANTENNA (2.0 TO 20.0 MHZ)                AP910   11111
219900
219900 ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.
219900
219900    FREQUENCY BANDWIDTH ........... 2.0 TO 20.0 MHZ
219900
219900 COUPLER - ANTENNA (0.3 TO 200 KHZ)                 AP911   11111
219900
219900 ANTENNA TO TRANSMITTER INTERFACE ALLOWING FOR MINIMUM RF LOSS.
219900
219900    FREQUENCY BANDWIDTH ........... 0.3 TO 200 KHZ
219900
003300 BANDPASS FILTER - WAVE ANALYSIS                    AP912   21111
003300
003300 DETERMINATION OF FREQUENCY AND AMPLITUDE INFORMATION ABOUT THE
003300 CARRIER AND SIDEBANDS.
003300
003300    FREQUENCY RANGE ................ 300 HZ TO 20.0MHZ
003300    ATTENUATION .................... 75 DB
003300    ACCURACY ....................... +/- 2 %
003300
    ROCKLAND SYSTEMS CORP          #1042F-01           $2028          111
        FREQUENCY RANGE .................. 0.01 HZ TO 111 KHZ
        FREQUENCY ACCURACY ............... +/- 2%
        PASS BAND GAIN ................... 0 OR 20 DB
        ATTENUATION SLOPE ................ 48 DB/OCTAVE

    KROHN-HITE                     #3342R              $2100          111
        FREQUENCY RANGE .................. 0.001 TO 99.9 KHZ
        FREQUENCY ACCURACY ............... +/- 2%
        PASS BAND GAIN ................... 0 DB OR 20 DB
        ATTENUATION SLOPE ................ 48 DB/OCT
        MAX ATTENUATION .................. 80 DB

    KROHN-HITE                     #3343R              $1950          111
        FREQUENCY RESPONSE ............... 0.01 TO 99.9 KHZ
        FREQUENCY ACCURACY ............... +/- 2%
        BAND PASS GAIN ................... 0 DB OR 20 DB
        ATTENUATION SLOPE ................ 48 DB/OCT
        MAX ATTENUATION .................. 80 DB

    GENERAL RADIO                  #1952               $1095          111
        FREQUENCY RANGE .................. 4 HZ TO 60 KHZ
        ATTENUATION RATE ................. 30 DB/OCT
        GAIN ............................. 0 DB OR -20 DB

    KROHN-HITE                     #3103 (R)           $650
        FREQUENCY RANGE .................. 10 HZ TO 3 MHZ
        ATTENUATION SLOPE ................ 24 DB/OCT

179500 PULSE WAVE ANALYZER- C.W. MODES                    AP913   11111
179500
    ROHDE AND SCHWARZ              #EZF (100.8831.52)  $19,485        111
        FREQUENCY RANGE .................. 6 KHZ TO 1.3 MHZ
        SENSITIVITY ...................... < 0.5 MICROVOLT

    TEKTRONIX INC                  #1L5 (PLUG-IN UNIT) $1300          111
        FREQUENCY RANGE .................. 50 HZ TO 1 MHZ
        DEFLECTION FACTOR ................ 1 MV/CM TO 100 V/CM

    HEWLETT PACKARD                #3590A/3594A        $4920          111
        FREQUENCY RANGE .................. 20 HZ TO 620 KHZ
        FREQUENCY ACCURACY ............... +/-(1 HZ + TIME BASE ACCURACY)
                                           FOR 20 HZ TO 62 KHZ BAND
                                           +/-(10 HZ + TIME BASE ACCURACY)
                                           FOR 500 HZ TO 620 KHZ BAND
        FREQUENCY RESOLUTION ............. 1 HZ/MINOR DIV (20 HZ TO 62KHZ)
                                           10 HZ/MINOR DIV (500 HZ-620KHZ)
        AMPLITUDE RANGE .................. 3 MICROVOLT TO 30 VFS,16 RANGES
        BANDWIDTH SPECIFIED .............. 10, 100, 1000, 3100 HZ
        SWEEP RATES ...................... 1, 10, 100, 1000, 3100 HZ/S
        MAX SWEEP TIME ................... 620 S +/- 15%

    HEWLETT PACKARD                #312A               $4275          111
        FREQUENCY RANGE .................. 1 KHZ TO 18 MHZ IN 18 OVERLAP-
                                           PING BANDS, 200 KHZ OVERLAP
        FREQUENCY ACCURACY ............... +/-(10 HZ + TIME-BASE ACCURACY)
        AMPLITUDE RANGE .................. -97 DBM TO 23 DBM FS 50-150 OHM
                                           -107 DBM TO 13 DBM 600 OHM

219900 PATCH PANEL                                        AP914   51111
219900
219900 INTERFACE CONNECTIONS OF VARIOUS RF RECEIVERS WITH SELECTED TEST
219900 EQUIPMENT FOR WAVE ANALYSIS.
219900
    TROMPTER ELEC.                 #JS1-52             $75            111
        VARIOUS SIZE  PATCH  PANELS, JACKS AND PLUGS ARE AVAILABLE
        FROM TROMPETER, CATALOG SHOULD BE CONSULTED FOR SPECIFIC
        APPLICATION. REVIEW INDICATES ITEMS COULD BE USED DIRECTLY
        IN SPACE

006180 AMPLIFIERS - WAVE ANALYSIS                         AP915   21111
006180
    HEWLETT PACKARD                #461A               $380           111
        FREQUENCY RANGE .................. 1 KHZ TO 150 MHZ
        FREQUENCY RESPONSE ............... +/- 1 DB INTO 50 OHM LOAD
        GAIN AT 500 KHZ .................. 40 DB +/- 0.5 DB OR 20 +/- 1 DB
        MAX INPUT ........................ 1 V RMS OR 2 V P-P PULSE

    TENNELEC               #TC 202/203                 $355/495       111
        GAIN.............................. 2.5 TO 3000X
        NON LINEARITY..................... LESS THAN 0.05%
        CONFIGURATION..................... NIM COMPATIBLE
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ROHDE AND SCHWARZ                  #ATN (100.0899.02)                  111
     FREQUENCY RANGE ................. 30 HZ TO 20 KHZ
     INPUT VOLTAGE ................... 0.25 - 25 VOLTS
     MAX POWER ....................... 50 WATTS

RESEARCH INC                       #812-11-17          $3200           111
     CAPACITY ........................ TO 33 PAIRS OF SIG WIRES (16GA)
     REFERENCE TEMP .................. HEAT SINK CONTROLLED TO +/- .08
                                       DEG C AT 65 DEG C
     AMBIENT TEMP .................... 0 TO 49 DEG C
     LEAKAGE RESISTANCE .............. 1000 MEG OHM
     HEAT-UP TIME FROM 22 DEG C ...... 50 MINUTES
     SETTLING TIME ................... 8 MS TO FINAL VALUE

HONEYWELL                          #ACCUDATA 117       $1340           111
     MULTICHANNEL WIDEBAND AMPLIFIER
     CHANNELS......................... 7
     MOUNT............................ BENCH

HONEYWELL                          #ACCUDATA 115       $5370           111
     HIGH VOLTAGE DC AMPLIFIER
     INPUT SIGNAL VOLTAGE............. +/-50MV TO 1500V
     OUTPUT SIGNAL VOLTAGE............ UP TO 2000V
     CHANNELS......................... 6

NEFF                               #122-222            $610            111
     GAIN.............................1 TO 2500
     COMMON MODE REJECTION............ 140DB
     DRIFT............................ 0.5MICROVOLT/OC
     STEP GAIN ACCURACY............... +/-0.01%
     SWITCH SELECTABLE FILTER
     BANDWIDTH........................ 100KHZ
     RACK/MODULE MOUNT

NEFF                               #126-621            $320            111
     AMPLIFIER MULTIPLEXER
     EMPLOYES FET SWITCH
     GAIN RANGE....................... 0.2 TO 2500
     COMMON MODE REJECTION............ 120DB
     OUTPUT........................... +/-10V AT 10 MILLIAMPERES

NEFF                               #127-102
     PROGRAMMABLE GAIN WITH SWITCH SELECTABLE OUTPUT FILTER
     GAIN STEPS....................... 1, 2, 5, 10, 20, 50, 100, 200,
                                       500,1000
     COMMON MODE REJECTION............ 140DB
     FET SWITCHING
     RACK/MODULE CONFIGURATION
TENNELEC                           #TC133              $295            111
     FET PREAMPLIFIER
     CHARGE SENSITIVITY............... 10E12 VOLTS/COULOMB
     INPUT............................ NEGATIVE INPUT PULSE POLARITY
                                       WITH INPUT CAPACITANCE >2000PF
     OUTPUT........................... POSITIVE OUTPUT PULSE POLARITY
                                      WITH OUTPUT IMPEDANCE 50 OHM
     STABILITY........................ 0.5%/V

181000 FREQUENCY SYNTHESIZER - WAVE ANALYSIS                 AP916   21111
181000
181000 TRANSLATION OF A STABLE FREQUENCY OF A PRECISE STANDARD TO ANY OF
181000 A SELECTED INVESTIGATION REQUIREMENT.
181000
181000    FREQUENCY BANDWIDTH ........... DC TO 13 MHZ IN 5 RANGES
181000    FREQUENCY RESOLUTION .......... 0.01 TO 10 KHZ
181000    FREQUENCY STABILITY ........... 1E-07 PARTS PER DAY
181000
GENERAL RADIO                      #1163-AR7C          $4990           111
     OUTPUT FREQUENCY RANGE .......... 30HZ TO 12MHZ
     SMALLEST STEP ................... 1HZ

ROHDE AND SCHWARZ                  #SMDH (100.4471.92)  $21585         111
     FREQUENCY RANGE ................. 0 TO 50 MHZ
     OUTPUT LEVEL .................... 0.1 MICROVOLT TO 2.5 VOLTS

HEWLETT PACKARD                    #3320B WITH OPTION   $3145          111
     FREQUENCY RANGE ................. 0.01 HZ TO 13 MHZ IN 7 RANGES
     RANGES .......................... 10 MHZ, 1000 KHZ, 100 KHZ, 10
                                       KHZ, 1000 HZ, 100 HZ, 10 HZ
     FREQUENCY STABILITY ............. +/- 10 IN 1E+6 OF SETTING/YEAR
     FREQUENCY RESPONSE .............. +/- 0.05 DB 10 HZ TO 13 MHZ
     AMPLITUDE RANGE ................. +26.99 DBM TO -69.99 DBM INTO
                                       50 OHMS

WAVETEK                            #162                $845            111
     BANDWIDTH ....................... 0.00003 HZ TO 30 MHZ
     OUTPUT .......................... 80 DB ATTENUATION/10 DB STEPS
                                       10 V P-P INTO 50 OHMS
     DC OFFSET ....................... +/- 5 VOLTS INTO 50 OHMS
     STABILITY ....................... +/- 0.05%/10 MIN, +/- 0.25%/24
                                       HOURS
SINGER                             #6600            $4000-5000         111
     FREQUENCY RANGE.................. 100KHZ TO 18GHZ
     POWER OUTPUT..................... UP TO 100MW
     PLUG-INS......................... 13 FOR VARIOUS OUTPUT RANGES
                                       PLUG-INS COST $2 TO 3000 EACH
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	JOHN FLUKE MFG CO INC 6456A-156P	$13,550	311
	FREQUENCY RANGE .... DC TO 50 MHZ		
	INCREMENTS .... 0.01 HZ		
	SPURIOUS OUTPUTS .... > 100 DB (NON-HARMONICS)		
	> 30 DB (HARMONICS)		
	SIGNAL-TO-PHASE NOISE RATIO ..... > 66 DB		
	FREQUENCY STABILITY .... 2E-9/24 HOURS AVAILABLE		
603002	MAIN BOOM A CONTROL	AP917	11134
603002			
603002	PLATFORM BOOM A CONTROL	AP918	11134
603002			
603002	MAIN BOOM B CONTROL	AP919	11134
603002			
603002	ALIGNMENT TV CONTROL	AP920	11134
603002			
603002	GIMBALLED PLATFORM CONTROLS	AP921	11134
603002			
603002	SM BOOM CONTROL	AP922	11134
603002			
603002	BOOM A POWER SUPPLY & DATA SYS CONTROL	AP923	11134
603002			
603002	BOOM B TARGET CONTROL	AP924	11134
603002			
603002	ACCEL-DECEL CONTROL	AP925	11134
603002			
603002	DISCHARGE FILAMENT HEATER CONTROL	AP926	11134
603002			
603002	DISCHARGE POTENTIAL CONTROL	AP927	11134
603002			
603002	PULSE SEQUENCE & BURST LENGTH CONTROL	AP928	11134
603002			
603002	GAS SELECTION & PRESSURE CONTROL	AP929	11134
603002			
603002	NEUTRALIZER EMISSION & BIAS CONTROL	AP930	11134
603002			
603002	CHARGE EXCHANGE CHANNEL ACTUATOR CONTROL	AP931	11134
603002			
603002	BEAM CURRENT MONITOR	AP932	11134
603002			
603002	ELECTRON BEAM VOLTAGE: CURRENT HEATER CONTROL	AP933	11134
603002			
603002	ELECTRON BEAM BURST LENGTH & MAGNITUDE CONTROL	AP934	11134
603002			
603002	ELECTRON BEAM EXPANSION LENS CONTROL	AP935	11134
603002			
603002	ELECTRON BEAM CURRENT MONITOR	AP936	11134
603002			
603002	PHASE, ANGLE, CURRENT MONITOR	AP937	11134
603002			
603002	MPD ARC VOLTAGE LEVEL CONTROL	AP938	11134
603002			
603002	MPD ARC BURST CURRENT DURATION CONTROL	AP939	11134
603002			
603002	MPD ARC PULSE SEQUENCE	AP940	11134
603002			
603002	MPD ARC BEAM CURRENT MONITOR	AP941	11134
603002			
603002	GAS SELECTION & PRESSURE CONTROL	AP942	11134
603002			
603002	SPHERICAL ION PROBE CONTROL	AP943	11134
603002			
603002	CYLINDRICAL ION PROBE CONTROL	AP944	11134
603002			
603002	PLANAR ELECTRON PROBE CONTROL	AP945	11134
603002			
603002	SEGMENTED PLANAR PROBE CONTROL	AP950	11134
603002			
603002	DEP. SAT. INSTRUMENT CONTROL & HOUSEKEEPING	AP959	11134
603002			
603002	DEP. SAT EJECTION MECHANISM CONTROL	AP960	11134
603002			
603002	PHOTOMETER HIGH VOLTAGE SUPPLY CONTROL	AP961	11134
603002			
603002	PHOTOMETER AMPLIFIERS CONTROL	AP962	11134
603002			
603002	TV SYS CONTROL - IMAGE INTENSIFIER CONTROL	AP963	11134
603002			
603002	CANNISTER EJECTION CONTROL	AP964	11134
603002			
603002	PROJECTILE CAMERA CONTROL	AP965	11134
603002			
603002	CANNISTER MONITOR	AP966	11134
603002			
603002	SHAPED CHARGE EJECTION CONTROL	AP967	11134
603002			
603002	SHAPED CHARGE MONITOR	AP968	11134
603002			
603002	BALLOON EJECTION CONTROL	AP969	11134
603002			
603002	GAS CONTROL SYSTEM	AP970	11134
603002			

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        EARTH OBSERVATIONS

204200 HEAT EXCHANGER                                          EC001   11121
204200
204200 EXCHANGER TO TRANSFER HEAT FROM THE CLOUD PHYSICS LAB TC THE
204200 SPACELAB HEAT REJECTION SUBSYSTEM
204200
204200    HEAT TRANSFER RATE.............185 BTU/HR (54 WATTS THERMAL)
204200    SPACELAB COOLANT INLET TEMP...43F (6C)
204200    CPL COOLANT OUTLET TEMP........45F (7C)
204200
205000 HEAT EXCHANGER                                          E0001   11121
205000
205000 PROVIDE HOT FLUID TO CPL
205000
205000    CPL COOLANT OUTLET TEMP.......100F (38C)
205000    HEAT RATE (EST)................170BTU/HR (50 WATTS THERMAL)
205000
410000 RESERVOIR                                               EC001   11113
410000
410000 STORES COOLANT.
410000
415500 PUMP                                                    E0001   11111
415500
415500 PUMP COOLANT IN CPL COOLANT SUBSYSTEM
415500
415500    FLOW RATE(EST)..................40LBS/HR (300CC/MIN)
415500    HEAD(EST).......................1 PSI (6.9E03 N/M2)
415500
487000 TEMPERATURE CONTROLLER                                  EC001   11111
487000
487000 CONTROLS COOLANT TEMPERATURE TO CONTROL CHAMBER WALL TEMPS
487000
487000    TEMPERATURE RANGE..............-76 TO 104F (-60 TO 40C)
487000    ACCURACY.......................+/-0.2F (0.1C)
487000
108600 CRYOGENIC COOLER ASSEMBLY                               EC001   11114
108600
108600 PROVIDE LOW TEMPERATURE HEAT SINK TO EXPERIMENT CHAMBERS
108600
108600    MAXIMUM TEMPERATURE............-76F (-60C)
108600    HEAT SINK CAPACITY(EST).......1000BTU (290W THERMAL)
108600
414500 TEMPERATURE SENSORS                                     EC001   41111
414500
414500 MEASURE COOLANT TEMPERATURES
414500
414500    OPERATING TEMPERATURE RANGE...-76 TO 104F (-60 TO 40C)
414500    ACCURACY.......................+/-0.02F(+/-0.01C)
414500
     IRCON                         #SERIES 80           $1200
          RESOLUTION ..................... 0.1 DEG F
          T/C TYPE ....................... IRON/CONSTANTAN - TYPE J
                                           CHROMEL-ALUMEL - TYPE K
                                           COPPER-CONSTANTAN - TYPE T
          RANGE (RESPECTIVELY) ........... -30 TO 1600 DEG F
                                           -30 TO 1999 DEGF
                                           -100 TO 600 DEG F

     BLH ELECTRONICS               #BULLETIN  209 OR 207
          OPERATING RANGE................. -100 TO 200F

     OMEGA ENGINEERING, INC.       MODEL XT-10C         $295              11
          TEMP.RANGE                       -100 TO+175C
          NO. RANGES                       4
          ACCURACY                         1C
          RESPONSE TIME                    1 SEC.
          LENGTH EXTENT. LEADS             UP TO 1000 FT.

104100 CRT DISPLAY                                             E0001   11111
104100
104100 PROVIDES DISPLAY CAPABILITY INCLUDING ALPHANUMERICS. DYNAMIC AND
104100 DEFLECTION AND VIDEO AMPLIFIERS AND REQUIRED POWER SUPPLIES.
104100
     RESEARCH INC                  #33CC                $1580
          FORMAT..........................24 LINESX72 OR 80 CHARACTERS
               ...........................24 LINESX40 CHARACTERS
               .......... ................ 12 LINESX72 OR 80 CHARACTERS
          REFRESH RATE....................60 HZ
          TRANSFER RATE...................110 TO 2400 BAUD
          CHARACTER FORM..................5X7 DOT MATRIX
          DIMENSIONS......................15-1/2WX13-1/2HX23-1/2D INCH
          WEIGHT..........................39LB (17.7KG)

     BUNKER-RAMO CORP              #2217-12CPT          $950
          CHARACTER CAPACITY (MAX) ........ 960
          CHARACTERS/LINE (MAX) ........... 80
          LINES/DISPLAY (MAX) ............. 24
          CHARACTERS REPERTOIRE ........... 62 OR 92
          VIEWING AREA .................... 8.75 X 6.25
          REFRESH AREA .................... 54 FRAMES/SEC
          CHARACTER GENERATING METHOD ... 5X7 DOT MATRIX
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    TEKTRONIX INC                 #4002A/021-0033-00/ $13375         111
                                   021-00XX-00/4901/
                                   -751
       ALPHANUMERIC FORMAT ............. 39 LINES-65 NORMAL/ITALIC CHAR,
                                         1 LINE- 84 CHAR IN SCRATCH AREA
       CHARACTER SET ................... 96 UPPER/LOWER CHAR (ASCII)
       CHARACTER SIZE .................. 70 X 90 MILS
       CHARACTER GENERATION ............ 7 X 5 DOT MATRIX
       CURSOR .......................... PULSATING 7 X 9 MATRIX
       GRAPHIC INPUT MODE .............. 1024(X) X 1024(Y) ADDRESSABLE,
                                         1024(X) X 761(Y) VIEWABLE PTS;
                                         JOYSTICK CONTROLLED, CROSS-HAIR
                                         CURSOR.

104180 DIGITAL VISUAL DISPLAY                                  EC001   11111
104180
104180 DISPLAY NUMERIC DATA
104180
101340 ALPHANUMERIC KEYBOARD                                   EC001   11111
101340
101340 ALLOWS CREWMAN TO COMMUNICATE WITH THE ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS
101340
101340     KEYBOARD.......................TYPEWRITER TYPE
101340     INTERFACE DESCRIPTION..........DIGITAL-12-BIT WORD
101340
    BUNKER-RAMO CORP              #2200           $440           111
       KEYS ............................ TYPEWRITER SET STD
       PROGRAM ASSIST KEYS ............. 16
       INTERFACE ....................... CRT
       EDITING KEYS .................... FULL SET

527000 SOLENOID VALVES                                         E0001   101121
527000
    ALTEX SCINTIFIC               #200                           111
       VARIOUS CHEMICALLY INERT FITTINGS AND VALVES
       TUBING .......................... $4 -$12/10FT
       VALVES .......................... $45 -$55
       INJECTION VALVES................. $115 -$140

527000 CONTROL FLUID FLOW
527000
527000 MODULATING VALVE                                        FC001   21121
527000
527000 ADJUST FLUID FLOW
527000
    ALTEX SCIENTIFIC              #200                           111
       VARIOUS CHEMICALLY INERT FITTINGS AND VALVES
       TUBING........................... $4 - $12/10FT
       VALVES .......................... $45 - $55
       INJECTION VALVES................. $115 - $140

527000 PRESSURE REGULATORS                                     E0002   51121
527000
527000 PRESSURE REGULATING VALVE FOR GASEOUS PRESSURIZATION SUBSYSTEM
527000
527000     REGULATION RANGE...............2.7 TO 14.7 PSIA(140 TO 760TORR)
527000     UPSTREAM PRESSURE(EST).........20 PSI (1.4E05 N/M2)
527000
    CARLE INSTRUMENTS INC         #6635           $72            111
       REGULATED PRESSURE .............. 0 TO 60 PSIG
       SOURCE PRESSURE ................. UP TO 3000 PSIG
       REGULATION ...................... +/- 0.1%

527000 PRESSURE REGULATOR                                      EC002   11121
527000
527000 VALVE REGULATING SUPPLY PRESSURE
527000
527000      REGULATION PRESSURE(EST)......20 PSI (1.4E04 N/M2)
527000      MAX UPSTREAM PRESSURE.........300  PSI (2.1 E06 N/M2)
527000
    CARLE INSTRUMENTS INC         #6635           $72            111
       REGULATED PRESSURE .............. 0 TO 60 PSIG
       SOURCE PRESSURE ................. UP TO 3000 PSIG
       REGULATION ...................... +/- 0.1%
    ALTEX SCIENTIFIC              #200                           111
       VARIOUS CHEMICALLY INERT FITTINGS AND VALVES
       TUBING........................... $4 - $12/10FT
       VALVES .......................... $45 - $55
       INJECTION VALVES ................ $115 - $140


527000 SOLENOID VALVES                                         E0002   111121
527000
    ALTEX SCIENTIFIC              #200                           111
       VARIOUS CHEMICALLY INERT FITTINGS AND VALVES
       TUBING .......................... $4 - $12/10FT
       VALVES .......................... $45 - $55
       INJECTION VALVES................. $115 - $140

527000 GAS SHUTOFF VALVES
527000
    ALTEX SCIENTIFIC              #200                           111
       VARIOUS CHEMICALLY INERT FITTINGS AND VALVES
       TUBING .......................... $4 - $12/10FT
       VALVES .......................... $45 - $55
       INJECTION VALVES ................ $115 - $140
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159100 CONDITIONING CHAMBER                                  E0015   11134
159100
159100 THE CONDITIONING CHAMBER IS MADE UP OF A PRESSURE SHELL, A
159100 POSITIVE EXPULSION REGULATOR AND A WV AEROSOL CONDITIONER. THIS
159100 CHAMBER CONDITIONS THE GAS SAMPLE PRIOR TO ITS INJECTION INTO
159100 THE CLOUD CHAMBER
159100
159100    OPERATING PRESSURE(EST).......20PSIA (14E03N/M2)
159100    OPERATING TEMPERATURE.........32 TO 86F (0 TO 30C)
159100    VOLUME........................2 CU.FT. (0.0565 CU. METERS)
159100
408800 PRESSURE SENSORS                                      E0002   51111
408800
408800 MEASURE PRESSURES THROUGH OUT THE SYSTEM
408800
408800    RANGES........................2 TO 20 PSIA (100 TO 1000 TORR)
408800          ........................10 TO 50 PSI (6.9E4-34.5E4N/M2)
408800          ........................10 TO 300 PSI (34.5E4-2.1E6N/M2)
408800    ACCURACY......................1% OF FULL SCALE
408800
   BENDIX ENVIRONMENTAL SCI.DIV.  MODEL 655                            111
      TEMP.RANGE                        -65 TO +150C
                                        -85 TO +300C
      PRESS.RANGE                       -2 TO +18PSI
      PROOF PRESS.                      0 TO 35 PSIG

   BLH ELECTRONICS              #DHF            $275 - 350             111
      FULL SCALE RANGES.................FROM 20PSI
      RATED OUTPUT...................... 3.0 MV/V
      CALIBRATION ACCURACY............. 0.25% FS

211000 HUMIDIFIER ASSEMBLY                                   E0003   11135
211000
211000 THIS ASSEMBLY CONSISTS OF AN EVAPORATOR, A HEATER, A WATER TRAP,
211000 A METERING PUMP AND A WATER TANK WITH AN INTEGRAL BLADDER. THIS
211000 ASSEMBLY GENERATES THE WATER VAPOR NECESSARY FOR CLOUD CREATION.
211000
211000    DRY AIR FLOW RATE.............175CFM (5 LITERS/MIN)
211000    MAXIMUM TEMPERATURE...........77F (45C)
211000    HUMIDITY RANGE................0 TO 100%
211000    HEATER CAPACITY(MIN)..........17BTU/HR (5W THERMAL)
211000    HEATER FEED RATE (MAX) ....... 0.02 LB/HR (9.1 CC/HR)
211000    WATER TANK CAPACITY...........3LBS (1.35KG)
211000
211300 DEW POINT SENSOR                                      E0003   11113
211300
211300 THIS SENSOR MEASURES THE DEW POINT OF THE GAS SAMPLE
211300
211300    MEASUREMENT RANGE.............10 TO 98%
211300    ACCURACY......................+/-1%
211300
211300 LIQUID WATER CONTENT METER                            E0003   11235
211300
211300 MONITORS LIQUID WATER CONTENT WITHIN THE EXPANSION CHAMBER FOR
211300 THE PURPOSE OF ACCURATE WATER BUDGET ACCOUNTS. CURRENT CONCEPTS
211300 USE OPTICAL TECHNIQUES TO MEASURE THE WATER DROPLETS IN AIR.
211300
211300    ACCURACY......................+/-0.05%
211300
603013 CONDENSER - WATER                                     E0003   11131
603013
603013 COLLECTS WATER VAPOR BY CONDENSING WATER CONTENT OF GAS SAMPLE
603013
603013    CONDENSATION RATE(MAX)........0.2LB/HR (91CC/HR)
603013    TEMPERATURE(MIN)..............45F(7C)
603013
410000 STORAGE TANK - EARTH SAMPLE                           E0004   11113
410000
410000 THIS TANK STORES SAMPLES OF EARTH GASSES. THE ASSEMBLY CONSISTS
410000 OF A PRESSURE VESSEL, A POSITIVE EXPULSION REGULATOR AND A
410000 BLADDER.
410000
410000    PRESSURE......................1 ATM (760 MM HG)
410000    VOLUME........................10 CU.FT.(0.28 CU.METERS)
410000
410000 GAS SAMPLE STORAGE TANKS                              E0004   51111
410000
410000 PRESSURE VESSELS FOR STORING EXPERIMENT GAS SAMPLES.
410000
410000    MAX PRESSURE(EST).............300 PSI (2.1E06 (N/M2)
410000    VOLUME                        1 CU.FT. (0.028 CU. METERS)
410000
410000 SUMP STORAGE TANK                                     E0004   11111
410000
410000 STORE GAS SAMPLES AFTER EXPERIMENT EVALUATION.
410000
410000    MAX PRESSURE (EST)............150PSI(1.05E06N/M2)
410000    VOLUME........................10 CU.FT. (0.28 CU.METERS)
410000
526200 FLOW CONTROL ASSEMBLY                                 E0004   11124
526200
526200 THIS ASSEMBLY CONTROLS THE FLOW OF GASSES IN THE CPL. IT IS MADE
526200 UP OF PLUMBING COMPONENTS, SOLENOID VALVES, A FILL ASSEMBLY, A
526200 VENT ASSEMBLY, SAFETY COMPONENTS AND A MIXING SUBASSEMBLY.
526200
409500 SUMP COMPRESSOR                                       E0004   11111
409500
409500 COMPRESS EXPENDED EXPERIMENT GAS SAMPLES INTO SUMP STORAGE TANK
409500
409500    COMPRESSION RATIO(MAX)........10 TO 1
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405500
405500 DC-DC CONVERTER(VOLTAGE CONTROLLED DC)              EC005   11111
405500
405500 CONVERTS SPACELAB POWER TO VOLTAGE USABLE BY ELECTRICAL FIELD
405500 GENERATING COMPONENTS
405500
405500    INPUT VOLTAGE.....................28V DC
405500    OUTPUT VOLTAGE....................TBD
405500
405500 DC-DC CONVERTER (LOW FREQUENCY AC)                  EC005   11111
405500
405500 CONVERT POWER INTO USABLE FORM FOR ELECTRIC FIELD GENERATING
405500 CAPACITOR
405500
405500    FREQUENCY.........................0 TO 100HZ
405500    WAVE SHAPE........................SQUARE
405500    AMPLITUDE.........................0 TO 3000 V/M
405500
605005 ELECTRIC FIELD CONTROLLER                           EC005   11114
605005
605005 PROVIDE CONTROL FUNCTION FOR ELECTRIC FIELD GENERATOR. CONTROLLER
605005 SUPPORT BOTH AC AND DC POWER SUPPLIES
605005
003110 ACOUSTICAL GENERATOR                                ED013   11111
003110
003110 VARIABLE FREQUENCY AUDIO DRIVERS USED TO POSITION AND CONTROL
003110 WATER DROPLETS OR ICE PARTICLES IN EACH OF THREE MUTUALLY
003110 PERPENDICULAR AXES. EACH DRIVER CAN BE CONTROLLED INDEPENDENTLY
003110 IN FREQUENCY AND AMPLITUDE
003110
003110    FREQUENCY RANGE...................0 TO 10KHZ
003110    AMPLITUDE.........................0 TO TBD DB
003110
    EDO WESTERN CORP              #415               $19860         113
       FREQUENCY ...................... 7 OR 3.5 KHZ
       ACOUSTIC LEVEL ................. 107 DB
       BEAM WIDTH ..................... 30 DEGREES

003210 TRANSDUCER - ACOUSTICAL                             ED013  241111
003210
003210 MEASURE SOUND INTENSITY LEVEL
003210
003210    INTENSITY LEVEL............... 0 TO TBD DB
003210
    KAMAN CORP                    #KM-1800           $1060          111
       RANGE .......................... 100-180 DB
       FREQUENCY RESPONSE ............. 0-10 KHZ

006180 AMPLIFIER - ACOUSTIC GENERATOR                      EC013   11111
006180
006180 AMPLIFY SIGNAL TO ACOUSTIC GENERATOR
006180
006180    POWER.............................45W
006180
227000 LASER                                               ED013   11111
227000
227000 POLARIZED, COLLIMATED LIGHT SOURCE USED FOR PARTICLE HEATING AND
227000 MOTION CONTROL AS WELL AS TO ASSESS OPTICAL SCATTERING PROPERTIES
227000 OF ICE CRYSTALS
227000
    SYLVANIA ELECTRONICS          #948               $10,000
       OUTPUT.......................... 5 WATTS AT 10.6 MICRONS
       FREQUENCY STABILITY............. < 15 MHZ AFTER 1/2 HR WARM-
                                        UP, OVER SEVERAL HOURS
       AMPLITUDE STABILITY.............< 5 %
       WEIGHT..........................27LBS (HEAD), 40LBS PWR SPLY

    HOLOBEAM INC                  #256               $13000         115
       WAVELENGTH......................0.53 OR 1.06 MICRONS
       MODE ........................... MULTI OR TEM..
       CW POWER ....................... TO 50 WATTS

    INTERNATIONAL LASER SYSTEMS   #NP-210            $36050         112
       TYPE ........................... ROTATING PRISM Q-SWITCHED OR
                                        POCKELS CELL Q-SWITCHED
       WAVELENGTH ..................... 1.06 MICRONS
       PULSE ENERGY ................... 100 OR 150 MJ MIN
       REPETITION RATE ................ UP TO 20 PPS

    SYLVANIA ELECTO-OPTICS ORG.   #948               $10000         111
       OUTPUT WAVELENGTH............... 10.6 MICRONS
       POWER OUTPUT.................... 5 WATTS MINIMUM
       MODE PURITY..................... TEM-000, SINGLE FREQUENCY
       BEAM DIAMETER................... 6 MM
       BEAM DIVERGENCE.................5 MRAD FULL ANGLE
       BEAM POLARIZATION............... VERTICALLY
       SIZE & WEIGHT
         POWER SUPPLY.................. 17 X 9.25 X14 IN, 40 LBS
       POWER INPUT..................... 115V, 60HZ AT 600VA
       COOLING......................... 0.25 GPM, WATER

    HOLOBEAM INC                  #255               $10000         112
       WAVELENGTH......................0.53 OR 1.06 MICRONS
       MODE ........................... MULTI OR TEM..
       CW POWER ....................... TO 25 WATTS
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603002 LASER - POSITIONING SERVO CONTROL                     EC013   41114
603002
603002 PROVIDES FEEDBACK AND CONTROL SIGNAL TO LASER DRIVER  FOR PROPER
603002 POSITIONING AND HEATING OF PARTICULATE SPECIMENS
603002
039575 LIQUID DROP GENERATOR                                 E0006   41235
039575
039575 GENERATES SINGLE DROPLETS BY MANUAL OR SYSTEM CONTROL. DROPLETS
039575 ARE PROPELLED INTO THE EXPERIMENT CHAMBERS FOR EXAMINATION
039575
039575    FORMATION FREQUENCY(MAX)......10/SEC
039575    DROPLET DIAMETER..............10 MICROMETERS TO 1 CM
039575    DROPLET UNIFORMITY............WITHIN 5 %
039575
407500 ELECTRONIC DRIVER ASSEMBLY                            E0006   41114
407500
407500 THE ELECTRONIC DRIVER ASSEMBLY CONTROLS THE LIQUID DROP
407500 GENERATOR. IT CONSISTS OF A GENERATOR POWER SUPPLY, A PARTICLE
407500 CHARGER POWER SUPPLY AND A DUAL PULSE GENERATOR.
407500
039580 ICE PARTICLE GENERATOR                                EC007   31235
039580
039580 GENERATE ICE PARTICLES FOR TEST IN ICE DIFFUSION, EXPANSION AND
039580 GENERAL CHAMBERS
039580
039580    ICE CRYSTAL SIZE..............50 MICROMETERS TO 1 CM
039580
003400 DROPLET CLOUD AEROSOL GENERATORS                      EC008   11135
003400
003400 GENERATE AEROSOLS FOR EXPERIMENTATION
003400
003400    PARTICLE CONCENTRATION........10 UP TO 10000/CC
003400    CLOUD FORM....................POLYDISPERSED AND MONODISPERSED
003400    PARTICLE SIZE.................10E-4 TO .1 CM
003400    PRODUCTION RATE...............UP TO 10E5 HZ
003400
     METRONICS ASSOCIATES          #BULLETIN 24-70                     111

003400 LARGE AND GIANT NUCLEI AEROSOL GENERATOR              E0008   11135
003400
003400 SAME AS DROPLET CLOUD AEROSOL GENERATOR
003400
003400 AITKEN AEROSOL GENERATOR                              EC008   11135
003400
003400 SAME AS DROPLET CLOUD AEROSOL GENERATOR
003400
102700 DIGITAL COMPUTER                                      EC010   11111
102700
102700 PROVIDES DATA PROCESSING AND CONTROL FUNCTIONS FOR THE CPL
102700
     DATA GENERAL CORP             #NOVA 80C          $18450           111
          WORD LENGTH ...................... 16 BIT
          CYCLE TIME ....................... 800 NANOSEC.
          CORE MEMORY ...................... 32K MAX

     DATA GENERAL CORP             #SUPERNOVA SC      $5600
          WORD LENGTH ...................... 16 BIT

     VARIAN DATA MACHINES          #520/I                              111
          MEMORY CYCL  TIME ................ 1.5MICROSEC.
          MEMORY ........................... EXPANDABLE,4096BYTES(8BITS)TO
                                             32,768BYTES
          REGISTERS ........................ 12
          OPERAND PRECISION ................ UP TO 32 BITS
          ADDRESS REFERENCE ................ 8,16,24,OR 32 BIT LEVEL
          NOTE:                              HAS FULL RANGE INTERFACE
                                             HARDWARE

     VARIAN DATA MACHINES          #R-620/1                            111
          BASIC COMMANDS  .................. OVER 100
          ADDRESSING MODES  ................ 6
          MAX.WORDS  ....................... 32,768
          WORD LENGTH  ..................... 16 OR 18 BIT
          REGISTERS  ....................... 9
          NOTE:                              HAS FULL RANGE INTERFACE
                                             HARDWARE

     CLARY DATACOMP SYSTEMS INC    #404                                111
          SIMULTANEOUS TERMINALS ........... 16
          INPUT ............................ TELETYPEWRITER KEYBOARD
          ACCUMULATOR ...................... 64 BIT
          REGISTERS ........................ 16 BIT INDEX (2 EACH)
          WORD LENGTH ...................... 16, 32, 48, 64 BITS
          MEMORY CAPACITY .................. 1024 16 BIT WORDS, 4096 16 BIT
                                             WORDS,OR ADDITIONAL 4096 16 BIT
                                             WORDS, TOTAL 65538 WORDS

     GENERAL AUTOMATION INC.       #18-30                              111
          FUNCTION ......................... SUPERVISE SMALLER COMPUTERS
          MEMORY............................ 8K CORE
          CYCLE TIME ....................... 1.2 MICROSEC.

     GENERAL AUTOMATION INC.       #SPC-16                             111
          MEMORY ........................... 16K
          WORD LENGTH ...................... 16 BITS
          READ/WRITE CYCLE MEMORY TIME ... 800 TO 1440 NANOSEC.
          READ ONLY MEMORY ................. 400 TO 720 NANOSEC.
          INPUT/OUTPUT TIME ................ 1.6 TO 2.8 MICROSEC.
          DMA TRANSFER RATE ................ 0.694E+06 TO 2.5E+06
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GENERAL AUTOMATION INC.        #SPC-12                              111
     MEMORY ......................... 4K TO 16K
     WORD LENGTH .................... 8 BITS
     CYCLE TIME ..................... 2.16 MICROSEC
     STORED PROGRAM EXECUTION RATE .. 0.23E+06/SEC
     I/O TRANSFER RATE .............. 0.46E+06/SEC
     REGISTERS ...................... 6 12 BIT REGISTERS
     ACCUMULATORS ................... 4 12 BIT

DATA GENERAL CORP              #NOVA 1200          $11900
     WORD LENGTH .................... 16 BIT
     CYCLE TIME ..................... 1200 NANOSEC.
     CORE MEMORY .................... 32K MAX.

DIGITAL EQUIPMENT CORP         #PDP-8/E            $22000           111
     MEMORY ......................... 4096(CORE)EXPANDABLE TO
                                      32,768 WORDS
     WORD ........................... 12 BIT
     CYCLE TIME ..................... 1.5 MICROSEC.
     OPTIONS:........................ DEC-DISC(131,072 WORDS STORAGE)
                                      MAGNETIC TAPE, TAPE READER,
                                      TAPE PUNCH, CARD EQUIP, LINE
                                      PRINTER, A/D & D/A CONVERT.,
                                      CRT DISPLAY

424000 TAPE RECORDER                                       EC010   11111
424000
424000 RECORD DATA ON MAGNETIC TAPE
424000
424000    BIT RATE.......................100M/S
424000    STORAGE CAPACITY...............3.5EC7BITS
424000
   AMPEX CORPORATION           #AR-200                              121
     BANDWIDTH ...................... 100 HZ TO 3125 HZ THROUGH
                                      300 HZ TO 250 KHZ
     TAPE WIDTH ..................... 0.5 INCH
     TAPE SPEED ..................... 1.875 TO 60 IPS
     RECORDING TIME ................. 8 MINUTES TO 4 HRS AND 16 MINS
     FORMAT ......................... DIGITAL
     TRACKS ......................... 8 DIGITAL, 7 ANALOG

   AMPEX CORP                  #AR 1700           $28,000           112
     TRACKS ......................... 14
     TAPE SPEED ..................... 120 IPS
     TAPE WIDTH ..................... 1 INCH
     RECORDING MODE.................. DIRECT
     PACKING DENSITY ................ 20 KB/I/T
     SIGNAL/NOISE ................... 20 DB
     DATA CAPACITY .................. 6.2E+10 BITS
     BANDWIDTH ...................... 2 MB/SEC/T
     TAPE LENGTH.....................9200 FEET

   SANGAMO ELECTRIC            #SABER III          $26,500          111
     TRACKS ......................... 14
     TAPE WIDTH ..................... 1 IN
     TAPE SPEEDS .................... 8 SELECTABLE SPEEDS FROM 15/16
                                      TO 120 IPS
     FREQUENCY RESPONSE ............. 400 HZ TO 2.0 MHZ
     RECORDING RATE ................. 600 KBPS AT 120IPS SERIAL MODE
     WEIGHT ......................... 100 POUNDS

   DIGI-DATA CORPORATION       #1600               $2650            111
     TAPE SPEED ..................... 25, 18.75, 12.5 IPS
     TRACKS ......................... 7 OR 9 TRACK
     DATA DENSITY ................... 1600 CPI PHASE ENCODED
                                      200, 556, 800 CPI NRZI
     TAPE ........................... 0.5 INCH, 1.5 MIL, 1200 FEET

   DIGI-DATA CORPORATION       #1700/PDP-11/7-9    $5250            111
                                  TRACK NRZI
     TAPE SPEED ..................... 45, 37.5, 25, 18.75, 12.5 IPS
     TAPE ........................... 0.5 INCH, 1.5 MIL, IBM/ANSI
                                      COMPATIBLE, 10.5 INCH REEL
     TRACKS ......................... 7 OR 9
     DATA DENSITY ................... PHASE ENCODED
                                      COMPATIBLE

   HEWLETT PACKARD             #7570B/C            $ 4600           111
     TAPE FORMAT ... ................ 800, 556, OR 200 CPI NRZI AND
                                      1600 CPI PHASE-ENCODED
     CHANNELS ....................... 7 OR 9
     TAPE SPEED ..................... 10 TO 45 IPS
     TAPE ........................... 0.5 INCH, 1.5 MILS, IBM/ANSI
                                      COMPATIBLE

   BORG WARNER                 #PERT                                121
     TRACKS ......................... 30
     TAPE SPEED ..................... UP TO 1000 IPS
     TAPE WIDTH ..................... 1/2 INCH
     TAPE LENGTH .................... 2400 FEET
     PACKING DENSITY ................ 15 KB/I/T
     SIGNAL/NOISE ................... 24 DB
     DATA CAPACITY .................. 1.3E+9
     BANDWIDTH ...................... 6-15 MB/SEC/T

   LEACH                       #MTR 7000                            311
     TRACKS ......................... 12
     TAPE SPEED ..................... 120 IPS
     TAPE WIDTH ..................... 1 INCH
     TAPE LENGTH..................... 9200 FEET
     PACKING DENSITY................. 16.7 KB/I/T
     SIGNAL/NOISE ................... 22 DB
     DATA CAPACITY .................. 3.2E+10
     BANDWIDTH ...................... 2 MB/SEC/T
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HEWLETT PACKARD                #3955D                 $10200          111
     BANDWIDTH ...................... 300 KHZ
     CHANNELS ....................... 7
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                #3955C                 $14700          111
     BANDWIDTH ...................... 300 KHZ
     CHANNELS ....................... 14
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                #3950A-011             $23800          111
     BANDWIDTH ...................... 500 HZ TO 2 MHZ
     CHANNELS ....................... 14
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                #3960A/13065A/13063A $4796             111
     CONFIGURATION .................. RACK MOUNTED
     TAPE SPEED ..................... 15, 3 AND 3/4, 15/16 IPS
     CHANNELS ....................... 4
     RECORDING FORMAT ............... FM
     PASSBAND ....................... 5 KHZ
     S/N RATIO....................... 48 DB
     TRACKS ......................... 30

HONEYWELL                      #5600                  $9730
     PORTABLE TAPE RECORDER
     CHANNELS........................ 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 60IPS
     MAXIMUM BANDWIDTH(DIRECT)....... 300KHZ
     PACKING DENSITY................. UP TO 600PBI
     WEIGHT.......................... 70LBS (32KG)
     INPUT VOLTAGE                    28VDC

HONEYWELL                      #96                    $17420
     CHANNELS........................ 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 240IPS
     REEL SIZE....................... 16IN
     MAXIMUM BANDWIDTH(DIRECT)....... 2M HZ
     TAPE WIDTH...................... 1/2 IN
AMPEX CORP                     #AP 700                $29,180         511
     TRACKS ......................... 14
     TAPE SPEED ..................... 60 IPS
     TAPE WIDTH ..................... 1 INCH
     RECORD MODE..................... DIRECT
     PACKING DENSITY ................ 20 KB/I/T
     SIGNAL/NOISE ................... 20 DB
     DATA CAPACITY .................. 8E+10 BITS
     BANDWIDTH ...................... 1 MB/SEC/T

603003 SIGNAL CONDITIONING ELECTRONICS                       E0010   11111
603003
603003 ELECTRONICS SUPPORTING DATA MANAGEMENT SUBSYSTEM
603003
ALS                            #SERIES X-1            $4000           111
     ACCURACY ....................... +/-0.0008%FS
     FUNCTIONS ...................... DC VOLTS, AC VOLTS, MILLIVOLTS,
                                      K OHMS AND RATIO
     COMMON MODE REJECTION .......... >136DB

HEWLETT PACKARD                #461A                  $380            111
     FREQUENCY RANGE ................ 1 KHZ TO 150 MHZ
     FREQUENCY RESPONSE ............. +/- 1 DB INTO 50 OHM LOAD
     GAIN AT 500 KHZ ................ 40 DB +/- 0.5 DB OR 20 +/- 1 DB
     MAX INPUT ...................... 1 V RMS OR 2 V P-P PULSE

TENNELEC              #TC 202/203             $355/495               111
     GAIN............................ 2.5 TO 3000X
     NON LINEARITY................... LESS THAN 0.05%
     CONFIGURATION................... NIM COMPATIBLE

ROHDE AND SCHWARZ              #ATN (100.0899.02)                     111
     FREQUENCY RANGE ................ 30 HZ TO 20 KHZ
     INPUT VOLTAGE .................. 0.25 - 25 VOLTS
     MAX POWER ...................... 50 WATTS

RESEARCH INC                   #812-11-17             $3200           111
     CAPACITY ....................... TO 33 PAIRS OF SIG WIRES (16GA)
     REFERENCE TEMP ................. HEAT SINK CONTROLLED TO +/- .08
                                      DEG C AT 65 DEG C
     AMBIENT TEMP ................... 0 TO 49 DEG C
     LEAKAGE RESISTANCE ............. 1000 MEG OHM
     HEAT-UP TIME FROM 22 DEG C ..... 50 MINUTES
     SETTLING TIME .................. 8 MS TO FINAL VALUE

HONEYWELL                      #ACCUDATA 117          $1340           111
     MULTICHANNEL WIDEBAND AMPLIFIER
     CHANNELS........................ 7
     MOUNT........................... BENCH

HONEYWELL                      #ACCUDATA 115          $5370           111
     HIGH VOLTAGE DC AMPLIFIER
     INPUT SIGNAL VOLTAGE............ +/-50MV TO 1500V
     OUTPUT SIGNAL VOLTAGE........... UP TO 2000V
     CHANNELS........................ 6

NEFF                           #122-222               $610            111
     GAIN............................1 TO 2500
     COMMON MODE REJECTION........... 140DB
     DRIFT........................... 0.5MICROVOLT/DC
     STEP GAIN ACCURACY.............. +/-0.01%
     SWITCH SELECTABLE FILTER
     BANDWIDTH....................... 100KHZ
     RACK/MODULE MOUNT
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    NEFF                          #126-621           $320        111
        AMPLIFIER MULTIPLEXER
        EMPLOYES FET SWITCH
        GAIN RANGE......................... 0.2 TO 2500
        COMMON MODE REJECTION............ 120DB
        OUTPUT............................ +/-10V AT 10 MILLIAMPERES

    NEFF                          #127-1C2           $1150
        PROGRAMMABLE GAIN WITH SWITCH SELECTAPLE OUTPUT FILTER
        GAIN STEPS......................... 1, 2, 5, 10, 20, 50, 100, 200,
                                            500,1000
        COMMON MODE REJECTION............ 140DB
        FET SWITCHING
        RACL/MODULE CONFIGURATION

    TENNELEC                      #TC133             $295        111
        FET PREAMPLIFIER
        CHARGE SENSITIVITY............... 10E12 VOLTS/COULOMB
        INPUT............................. NEGATIVE INPUT PULSE POLARITY
                                            WITH INPUT CAPACITANCE >2000PF
        OUTPUT............................ POSITIVE OUTPUT PULSE POLARITY
                                           WITH OUTPUT IMPEDANCE 50 OHM
        STABILITY......................... 0.5%/V

367000 OPTICAL PARTICLE COUNTER                            E0011   11235
367000
367000 THIS DEVICE WILL BE A SIZE ANALYZER. THE ANALYZER CONSISTS OF A
367000 PHOTOMULTIPLIER, AN AMPLIFICATION STAGE AND SUPPORTING
367000 ELECTRONICS
367000
367000      SENSITIVE PARAMETER............LIGHT SCATTERED FROM PARTICLES
367000      PARTICLE SIZE...................>0.3 MICROMETERS
    THERMO-SYSTEMS INC            #3030              $10700      111
        PARTICLE SIZING RANGE............ .0032 TO 1 MICRON
        CLASSIFICATION RANGE............. .01 TO .5 MILCRON
        SAMPLING RATE..................... 5 LITERS/MIN
        COUNTING CLASSIFICATIONS......... 10 SIZE CLASSES
        READOUT........................... COMPATIBLE WITH AUT DATA AC SYS
367000
367500 NUCLEI MASS MONITOR SYSTEM                          EC011   11235
367500
367500 THIS DEVICE MEASURES THE TOTAL PARTICULATE MASS PER UNIT VOLUME.
367500 THE SYSTEM USES A CRYSTAL OSCILLATOR WHICH CHANGES ITS RESONANT
367500 FREQUENCY AS PARTICLES ARE DEPOSITED ON IT.
367500
367500      PARTICLE COLLECTION............ELECTROSTATIC PRECIPITATION
367500      PARTICLE SIZE...................0.01 TO 20 MICROMETERS
367500
367000 ELECTRICAL PARTICLE COUNTER                         EC011   11135
367000
367000 THIS ANALYZER MEASURES THE SIZE DISTRIBUTION OF PARTICLES. THE
367000 PARTICLES ARE IONIZED AND THIER MOBILITY AS A FUNCTION OF
367000 ELECTRIC FIELD IS MEASURED TO GIVE AN INTEGRAL SIZE DISTRIBUTION
367000
367000      PARTICLE SIZE...................0.01 TO 1.0 MICROMETER
367000      FLOW RATE.......................1.8CFM (50LITERS/MIN)
367000      INTEGRAL DISTRIBUTION CAPABILITY.....YES
367000
    ORTEC                        #401A,109A,410,      $3000
                                  435,415
        RESOLUTION........................<2.5KEV
        LINE SHAPING......................SINGLE OR DOUBLE DELAY,OR
                                            SINGLE OR DOUBLE DIFFEREN-
                                            TIATION WITH TIME CONSTANTS
                                            OF 0.1 TO 10 MSEC
        COUNT RATE STABILITY............. <0.2% FOR 50000 COUNTS/SEC
        GAIN SHIFT ....................... <0.25% FOR 50000 COUNTS/SEC

    BAUSCH AND LOMB INC           #40-1A
        SAMPLING RATE .............. 0.1 FT**3/100 SEC (1E+7 PARTICLES
                                      PER FT**3)
        MAX CONCENTRATION MEAS .... 1E+7 PARTICLES/FT**3
                                      35E+2 PARTICLES/LITER
        PARTICLE SIZE RANGE ....... 0.3, 0.5, 1.0, 2.0, 3.0, 5.0, 10
                                      MICRONS

179500 ANALYZER - MULTICHANNEL                             E0011   11111
179500
179500 ALLOW SELECTIVE ANALYSIS OF COUNTER DATA
179500
    NUCLEAR DATA                 # ND 100            $7500
        DATA ACQUISITION MODES .......... PHA, MCS, OR LIST
        BANDWIDTH ........................ 15 MHZ
        STORAGE .......................... 12 BIT DATA  WORDS
        DISPLAY .......................... CRT, 6X10 CM
        NUMBER OF CHANNELS ............... 1024,2048,4096
        COUNT CAPACITY PER CHANNEL ...... 2**20 -0 1 + 4 INTERNAL
                                            FLAG BITS
        DIMENSIONS........................ 19X10.25X23.5 INCHES
        WEIGHT ........................... 60 LBS

297500 EXPANSION CLOUD CHAMBER                             E0014   11135
297500
297500 CHAMBER PROVIDING SIMULATION OF LONG TERM, NATURAL CLOUD DURING
297500 AN ADIABATIC EXPANSION
297500
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297500    DIMENSIONS.....................11.8IN.(30CM)DIA. X 17.7IN
297500                                   (45CM)LONG
297500    VOLUME.........................1.12CU.FT.(31.8L)
297500    OPERATING TEMPERATURE.......... -76F TO 104F (-60 TO 40C)
297500    UPPER AND LOWER ENDS TEMP
297500       DIFFERENTIAL................0 TO 18F(0 TO 10C)
297500    END TEMPERATURE TOLERANCE.....+/-0.1F (+/-0.5C)
297500    OPERATING PRESSURE.............2.7 TO 14.7 PSIA(140 TO 760TORR)
297500    PRESSURE RATE OF CHANGE........19.4PSI/SEC (1000TORR/SEC)
297500    PRESSURE RATE TOLERANCE.......+/-1%
297500    MAXIMUM VOLUME EXPANSION...... V/V OF 0.5+/-0.1%
297500    CIRCULAR ENDS CONTAIN ELECTRICALLY CONDUCTIVE PLATES TO SERVE
297500       AS EQUIPOTENTIAL SURFACES FOR THE ELECTRIC FIELD MOTION
297500       CONTROL SYSTEM
297500
297500 CONTINUOUS FLOW DIFFUSION CLOUD CHAMBER               E0014    11135
297500
297500 SUPERSATURATION IS CONTROLLED BY THE TEMPERATURE OF WATER
297500 COVERING THE UPPER AND LOWER SURFACES OF THE CHAMBER. IT WILL BE
297500 USED FOR CLOUD CONDENSATION NUCLEATION EXPERIMENTS
297500
297500    DIMENSIONS.....................11.8IN(30CM) X 11.8IN(30CM) X
297500                                   2IN(5CM)
297500    VOLUME.........................0.16CU.FT.(4.5L)
297500    INNER PLATE DIMENSIONS....... 11.8IN(30CM) X 10IN(25CM) SPACED
297500                                   0.5IN(1.3CM)APART
297500    ISOTHERMAL TEMP CONTROL.......+/-0.1F(0.05C)
297500    UPPER AND LOWER SURFACE
297500       TEMPERATURE DIFFERENCE..... 0 TO 18F (0 TO 10C)
297500    SURFACE TEMP CONTROL..........+/-0.1F(0.05C)
297500    OPERATING PRESSURE.............14.3 TO 14.7PSIA(740 TO 760TORR)
297500    PRESSURE MEAS. ACCURACY.......+/-0.2%
297500    MAX PRESSURE CHANGE RATE......0.08PSI/SEC(0.4TORR/SEC)
297500
297500 STATIC DIFFUSION ICE CLOUD CHAMBER                    E0014    11135
297500
297500 THIS IS A NAKAYA TYPE CHAMBER WHICH UTILIZES ICE SURFACES TO
297500 PROVIDE CONTROLLED SUPERSATURATION RELATIVE TO ICE.
297500
297500    DIMENSIONS.....................15.75IN(40CM)DIA X 7.9IN(20CM)
297500                                   LONG
297500    VOLUME.........................0.444CU.FT.(4.5L)
297500    OPERATING TEMPERATURE.........-40 TO 77F(-40 TO 25C)
297500    TEMP MEAS. ACCURACY...........+/-1.8F(+/-1.0C)
297500    UPPER AND LOWER SURFACE
297500      TEMPERATURE DIFFERENCE......UP TO 36F (20C)
297500    SURFACE TEMP.MEAS.ACCURACY....+/-0.1F(+/-0.05C)
297500    OPERATING PRESSURE.............1.9 TO 14.7PSIA(100 TO 760TORR)
297500    PRESSURE MEAS. ACCURACY.......+/-0.19PSI(+/-10TORR)
297500
297500 STATIC DIFFUSION LIQUID CLOUD CHAMBER                 E0014    11135
297500
297500 A THOMEY TYPE CHAMBER USED FOR EXPERIMENTS REQUIRING ABOVE
297500 FREEZING TEMPERATURES AND SUPERSATURATION OF THE LIQUID RELATIVE
297500 TO WATER. SUPERSATURATION IS CONTROLLED BY THE TEMPERATURES OF
297500 THE WATER COVERING CHAMBER UPPER AND LOWER SURFACES.
297500
297500    DIMENSIONS.....................6IN.(15 CM)DIA.X0.6IN(1.5CM)LONG
297500    VOLUME.........................0.01CU.FT.(0.27L)
297500    OPERATING TEMPERATURE........ 32F TO 68F (0 TO 30C)
297500    END SURFACE MAXIMUM
       TEMPERATURE DIFFERENTIAL.........18F(10C)
297500    SURFACE TEMP.MEAS.ACCURACY....0.1V(0.05C)
297500    OPERATING PRESSURE.............2.84 TO 14.7PSIA(140 TO 760TORR)
297500
297500 GENERAL CLOUD CHAMBER                                 E0014    11135
297500
297500 THIS CHAMBER WILL BE USED FOR MANY EXPERIMENTS THAT REQUIRE A
297500 RELATIVE HUMIDITY BELOW 100% AND MINIMUM TEMPERATURE CONTROL.
297500 PROVISIONS WILL BE MADE FOR GENERATING VARIOUS ELECTRIC FIELDS,
297500 POSITIONING DEVICES(SOUND, OPTICAL, ELECTRICAL), AND REMOTE
297500 DROPLET SIZING.
297500
297500    DIMENSIONS.....................11.8IN(30CM) ALL SIDES (CUBE)
297500    VOLUME.........................0.95CU.FT.(27L)
297500    OPERATING TEMPERATURE.........50 TO 86F(10 TO 30C)
297500    OPERATING PRESSURE.............2.84 TO 14.7PSIA(140 TO 760TORR)
297500    ELECTRIC FIELD PLATES LOCATED ON OPPOSITE SIDES
297500    ACOUSTIC DRIVERS LOCATED ON THREE MUTUALLY PERPENDICULAR SIDES
297500
405500 AC POWER CONTROLLER                                   E0017    11111
405500
405500 REGULATES AND CONTROLLS AC POWER
405500
405500    REGULATION RANGE..............TBD
405500
    JOHN FLUKE MFG CO INC          #4210A              $1445          111
         PROG CODING ..................... BCD (BINARY AVAILABLE)
         OUTPUT VOLTS .................... 0 TO +/- 10 VOLTS DC/PEAK AC
         OUTPUT CURRENT .................. 100 MA
         FREQUENCY RANGE ................. DC TO 100 KHZ
         RESOLUTION ...................... 1 MV
         REGULATION ...................... 0.001%

    JOHN FLUKE MFG CO INC          #4250A              $1795          111
         PROG CODING ..................... BCD (BINARY AVAILABLE)
         OUTPUT VOLTS .................... 0 TO +/- 65 VOLTS DC/PEAK AC
         OUTPUT CURRENT .................. 1 AMP
         FREQUENCY RANGE ................. DC TO 30 KHZ
         RESOLUTION ...................... 1 MV
         RESOLUTION ...................... 0.001%
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     JOHN FLUKE MFG CO INC          #427CA                  $1895          111
          PROG CODING ...................... BCD (BINARY AVAILABLE)
          OUTPUT VOLTS ..................... 0 TO +/- 100 VOLTS DC/PEAK AC
          OUTPUT CURRENT ................... 0.5 AMPS
          FREQUENCY RANGE .................. DC TO 30 KHZ
          RESOLUTION ....................... 1 MV
          RESOLUTION ....................... 0.001%

405500 DC POWER CONTROLLER                                          EC017   11111
405500
405500 REGULATES AND CONTROLS DC POWER
405500
405500    REGULATION RANGE...............TBD
405500
     JOHN FLUKE MFG CO INC          #421GA                  $1445          111
          PROG CODING ...................... BCD (BINARY AVAILABLE)
          OUTPUT VOLTS ..................... 0 TO +/- 10 VOLTS DC/PEAK AC
          OUTPUT CURRENT ................... 100 MA
          FREQUENCY RANGE .................. DC TO 100 KHZ
          RESOLUTION ....................... 1 MV
          REGULATION ....................... 0.001%

     JOHN FLUKE MFG CO INC          #425UA                  $1795          111
          PROG CODING ...................... BCD (BINARY AVAILABLE)
          OUTPUT VOLTS ..................... 0 TO +/- 65 VOLTS DC/PEAK AC
          OUTPUT CURRENT ................... 1 AMP
          FREQUENCY RANGE .................. DC TO 30 KHZ
          RESOLUTION ....................... 1 MV
          RESOLUTION ....................... 0.001%

     JOHN FLUKE MFG CO INC          #427CA                  $1895          111
          PROG CODING ...................... BCD (BINARY AVAILABLE)
          OUTPUT VOLTS ..................... 0 TO +/- 100 VOLTS DC/PEAK AC
          OUTPUT CURRENT ................... 0.5 AMPS
          FREQUENCY RANGE .................. DC TO 30 KHZ
          RESOLUTION ....................... 1 MV
          RESOLUTION ....................... 0.001%
054000 MOTION PICTURE CAMERA (FAST FRAME)                           E0009   11111
054000
054000 FAST FRAME RATE CAMERA TO RECORD DROPLET COLLISIONS
054000
054000   FRAME RATE.......................100/SEC
054000   RECORDING DURATION..............20SEC
054000   FIELD OF VIEW................... WIDE ANGLE
054000
055050 STILL CAMERA                                                 E0009   11111
055050
055050 RECORD CLOUD CHAMBER PHENOMENA
055050
055050    FRAME RATE.......................2/SEC
055050    SHUTTER SPEED....................1SEC TO 1/500SEC
055050    CAPACITY.........................500FRAMES
055050    INTERCHANGABLE LENSES
055050    FILM SIZE........................35MM
055050
     HONEYWELL INC                  #SPOTOMATIC F            $638          111
          LENS ............................. 55 MM, F/1.8 TAKUMAR
                                             35 MM, F/2.0 TO F/16 TAKUMAR
          SHUTTER SPEEDS ................... 1/1000 SEC TO TIMER
          VIEWING .......................... THRU LENS

055050 STILL CAMERA                                                 E0009   11111
055050
055050 RECORD CLOUD CHAMBER PHENOMENA
055050
055050    SHUTTER SPEED....................1SEC TO 1/500SEC
055050    RESOLUTION.......................2 MICROMETERS
055050    DEPTH OF FIELD...................1MM
055050    FRAME SIZE.......................70MM
055050
     GRAFLEX                        #XL                      $365          111
          CONFIGURATION .................... HAND HELD OR STAND MOUNTED
          FILM FORMAT ...................... 3.25 X 4.25 INCH
          LENS ............................. INTERCHANGEABLE

     HASSELBLAC                     #500 EL                 $1411          111
          TYPE ............................. SINGLE LENS REFLEX
          DRIVE ............................ ELECTRICAL OR MANUAL
          LENS ............................. 80 MM PLANAR F/2.8 ZEISS
                                             50 MM DISTACON F/4.0
          CLOSE-UP LENS .................... PROXAR 0.5 FOCUS RANGE
                                             17.25 TO 24.25 IN
                                             PROXAR 1.0 FOCUS RANGE
                                             22.25 TO 42.5 IN
          FILM SIZE ........................ 2.25 X 2.25 IN
          MAGAZINE ......................... CASSETTE AND PLATE

268500 MICROSCOPE                                                   E0017   11111
268500
268500 MAGNIFIED OBSERVATIONS
268500
268500    MAGNIFICATION FACTOR...........10 TO 100X
268500    OBSERVATION MODE...............VISUAL OR PHOTOGRAPHIC
268500
     BAUSCH AND LOMB INC            #R57-63W                 $876          111
          OBJECTIVES ....................... 4 FLAT FIELD
          TYPE OBJECTIVE ................... 5X, 0.8 NA; 10X, 0.25 NA; 40X,
                                             0.65 NA; 100X, 1.25 NA
          ILLUMINATOR ...................... 5 STEP, LOW VOLTAGE TRANSFORMER
          EYEPIECES ........................ PAIRED 10X
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    LEITZ                            #LZ051                $2101          111
        CONFIGURATION.................... BENCH MOUNT
        EYPIECE.......................... BINOCULAR
        MAGNIFICATION.................... 6.3X TO 100X

    AMERICAN OPTICAL                 #XH20T6-DW            $1576          111
        CONFIGURATION.................... BENCH MOUNT
        EYEPIECE......................... BINOCULAR
        MAGNIFICATION.................... 4X TO 100X

    OLYMPUS OPTICAL CO LTD           #JM                   $900           111
        CONFIGURATION ................... LOOSE EQUIPMENT
        TYPE ............................ DARKFIELD ZOOM-STEREO
        MAIN BODY ....................... BINOCULAR TUBE, INCLINED 45 OR
                                          60 DEG, ROTATABLE 360 DEG
        MAGNIFICATION RANGE ............. 3.5X TO 160X
        WORKING DISTANCE ................ 30, 45, 88, 105, 159 MM
        APERTURE IRIS DIAPHRAGM ......... 2 TO 40 MM (ADJUSTABLE)

    BAUCH & LOMB                     #PB-252               $1252          111
        CONFIGURATION.................... LOOSE EQUIPMENT
        EYEPIECE......................... BINOCULAR
        MAGNIFICATION.................... 4X TO 100X

269000 STEREO MICROSCOPE                                        EC017   11111
269000
269000 MAGNIFIED OBSERVATIONS
269000
269000    MAGNIFICATION FACTOR...........10 TO 100X
269000    OBSERVATION MODE...............VISUAL OR PHOTOGRAPHIC
269000    WORKING DISTANCE...............UP TO 4IN(10CM)
269000
    BAUSCH-LOMB INC.                 #B57-63W              $876           111
        OBJECTIVES ...................... 4 FLAT FIELD
        TYPE OBJECTIVES ................. 5X,0.08NA
                                          10X,0.25NA
                                          40X,0.65NA
                                          100X,1.25NA
        ILLUMINATOR ..................... 5 STEP,LOW VOLT.XFORMER
        EYEPIECES ....................... PAIRED 10X

    LEITZ                            #LZ051                $2101          111
        CONFIGURATION.................... BENCH MOUNT
        EYPIECE.......................... BINOCULAR
        MAGNIFICATION.................... 6.3X TO 100X

    AMERICAN OPTICAL                 #XH20T6-DW            $1576          111
        CONFIGURATION.................... BENCH MOUNT
        EYEPIECE......................... BINOCULAR
        MAGNIFICATION.................... 4X TO 100X

    OLYMPUS OPTICAL CO LTD           #JM                   $900           111
        CONFIGURATION ................... LOOSE EQUIPMENT
        TYPE ............................ DARKFIELD ZOOM-STEREO
        MAIN BODY ....................... BINOCULAR TUBE, INCLINED 45 OR
                                          60 DEG, ROTATABLE 360 DEG
        MAGNIFICATION RANGE ............. 3.5X TO 160X
        WORKING DISTANCE ................ 30, 45, 86, 105, 159 MM
        APERTURE IRIS DIAPHRAGM ......... 2 TO 40 MM (ADJUSTABLE)

    BAUCH & LOMB                     #PB-252               $1252          111
        CONFIGURATION.................... LOOSE EQUIPMENT
        EYEPIECE......................... BINOCULAR
        MAGNIFICATION.................... 4X TO 100X
268500 MICROSCOPE (HIGH MAGNIFICATION)                          EC017   11111
268500
268500 MAGNIFIED OBSERVATIONS
268500
268500    MAGNIFICATION FACTOR...........100 X 1000X
268500    OBSERVATION MODE...............TRINOCULAR(CAMERA ATTACHMENT)
268500
269000
    CARL ZEISS CO                    #ULTRAPHOT II         $8000          111
        CONFIGURATION ................... LOOSE EQUIP
        MAGNIFICATION ................... 2.5X TO 2500X
        CAMERA ATTACHMENT ............... POLAROID, 4X5 FILM, 35 MM ROLL

359500 OSCILLOSCOPE                                             E0017   11111
359500
359500 SUPPORT MAINTENANCE ACTIVITIES AND SPECIAL DATA ACQUISITION
359500
359500    FREQUENCY RANGE ............... DC TO 10.0 MHZ
359500    OBSERVATION MODE .............. VISUAL AND CAMERA (1 HR STORE)
359500
    TEKRONIX INC                     #R564B/3A6 PLUG-IN/   $2340          111
                                     3B4 PLUG-IN
        BANDWIDTH ....................... DC TO 10 MHZ
        CHANNELS ........................ 2
        DEFLECTION FACTOR ............... 10 MV/DIV TO 10 V/DIV
        TIME BASE ....................... 50 NS/DIV TO 5 S/DIV
        MAX VIEWING TIME ................ 1 HOUR
        MAX STORED WRITING SPEED ........ 500 DIV/MS
        TYPE OF STORAGE ................. SPLIT SCREEN BISTABLE

    TEKTRONIX                        #DM64                 $1095          111
        BANDWIDTH ....................... DC TO 10 MHZ
        RISETIME ........................ 35 NS
        SPEED WRITING ................... 25 CM/MS (NOMINAL)
                                          250 CM/MS (ENHANCED MODE)
        STORAGE VIDEO TIME .............. 1 HR
        ERASE TIME ...................... 0.25 S
        DEFLECTION FACTOR ............... 10 MV/CM TO 50 V/CM IN 12 STEPS
        TIME BASE ....................... 100 NS/CM TO 2 S/CM IN 23 STEPS
        RESPONCE TIME....................LESS THAN 1 NS
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HEWLETT-PACKARD                #132A              $1500          111
     BANDWIDTH ...................... DC TO 500MHZ
     SENSITIVITY .................... 100 MICROVOLTS/CM
     INDEPENDENT [illegible] ........ 2
     WEIGHT ......................... 43 POUNDS

TEKTRONIX INC                  #R465              $1800          111
     BANDWIDTH ...................... DC TO 100 MHZ
     CHANNELS ....................... 2
     DEFLECTION FACTOR .............. 5 MV/DIV TO 5 V/DIV
     TIME BASE ...................... 0.01 MICROSEC/DIV TO 0.5 S/D2*

TEKTRONIX                      #485               $4200          111
     RANGE,CALIBRATED................ 5MV/DIV TO 5V/DIV IN 10 STEPS
          UNCALIBRATED............... CONT VAR TO 12.5V/DIV
     RESPONSE TIME...................LESS THAN 1 NS
     CHANNELS........................ 1,ALTERNATE, CHOPPED,ADDED,X-Y
          ........................... CHANNEL 2 (+UP OR INVERTED)
     DIMENSIONS...................... 16.7 X 52.4 X 30.5 CM
     WEIGHT.......................... 9.5 KG
     POWER........................... 115/230V 48-440HZ  60W

TEKTRONIX INC                  #R5A18/3A6 PLUG-IN/  $1840        111
                                3A4 PLUG-IN
     FREQUENCY BANDWIDTH ............ DC TO 10 MHZ
     CHANNELS ....................... 2
     DEFLECTION FACTOR .............. 10 MV/DIV TO 10 V/DIV
     TIME BASE ...................... 50 NS/DIV TO 5 S/DIV
     RISETIME ....................... 35 NS

484000 TV MONITOR                                          EC012   11111
484000
484000 DISPLAY TV CAMERA OUTPUT SHOWING CHAMBER PHENOMENA
484000
   COHU ELECTRONICS INC           *COF               $775           111
     BANDWIDTH ...................... 30 MHZ
     HORIZONTAL LINES ............... 1225
     FIELDS ......................... 60 PER SEC

   COHU INC. ELECTRONICS DIV      MONITOR,TV         $              111
     PICTURE SIZE ................... 7-3/16W X 5-3/8H INCHES
     HORIZONTAL SCAN ................ 945 LINES, 50 OR 60 FIELDS/SEC
          ........................... 873 LINES, 60 FIELDS/SEC
     VIDEO BANDWIDTH ................ 20 MHZ +/- 2 DB
     POWER .......................... 25-28.5 VDC, 150 WATTS

480000 VIDICON                                             EC012   11111
480000
480000 RECORD CHAMBER PHENOMENA
480000
480000     RESOLUTION.....................HIGH
480000     LIGHT LEVEL....................LOW
480000     IMAGE MAGNIFICATION............YES
480000     IMAGE INTENSIFICATION..........YES
480000
   RCA ELECTRONICS COMPONENTS     #8521              $520           111
     TYPE ........................... VIDICON-SULFIDE
     PHOTOCONDUCTIVE ................ II
     IMAGE DIAGONAL ................. 25 MM (1 IN)
     FOCUS .......................... MANUAL
     LIMITING RESOLUTION ............ 1500 LINES

   COHU INC. ELECTRONICS DIV.     #1220              $8430          111
     IMAGE CONVERTER ................ 4846B VIDICON - COLOR
     RESOLUTION-HORIZONTAL LIMIT .... 300 LINES MIN.
     GEOMETRIC DISTORTION ........... < 2 % OF PIC HEIGHT
     LENS MOUNT ..................... 16 MM - C-MOUNT

   COHU INC. ELECTRONICS DIV.     #2000              $3000          311
     LENS-BUILTIN ................... 4:1 (20-80 MM) F/2.5 ZOOM
     LENS ATTACHMENT ................ 4:1 (12.5-80 MM)
     LENS INTERCHANGEABLE ........... 10:1 (15-150 MM) F/2.8 ZOOM
          ........................... 16 MM C-MOUNT FFL
     10 MHZ BANDWIDTH (MOD 2006) .... 525 OR 729 LINE (VIDICON 7263A)
     20 MHZ BANDWIDTH (MOD 2004) .... 873 OR 945 LINE (VIDICON 8573)
     MIL SPECIFICATIONS ............. MIL-E-5272C, MIL-STD-810

   COHU INC. ELECTRONICS DIVISION#4500               $2225          311
     LENS ........................... 4:1 ZOOM
          ........................... 10:1ZOOM
     VERTICLE SWEEP RATE ............ 60FIELDS PER SEC
     HORIZONTAL SWEEP RATE .......... 525 LINES PER FRAME
     IMAGE TUBE TYPE ................ 8541A STD
     LENS MOUNT                       16 MM C-MOUNT
     MIL SPECIFICATIONS ............. MIL-E-5400M, MIL-E-5300M

234000 IMAGE DEVICE LIGHTING                               E0009   11114
234000
234000 PROVIDES LIGHTING FOR VARIOUS OPTICAL RECORDING ACTIVITIES.
234000 CONSISTS OF CONTINUOUS LIGHTING, STROBOSCOPE AND LASER BEAM LIGHT
234000 SOURCES
234000
234000     HIGH INTENSITY LIGHT DURATION..<1SEC
234000
355500 OPTICAL DETECTOR                                    E0009   11235
355500
355500 SOLID STATE DETECTOR TO OBTAIN DATA CONCERNING SCATTERING
355500 PROPERTIES OF ICE CRYSTALS AND POSSIBLY EXTREME DROPLET SIZE
355500 CHANGE DATA.
355500
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211300 DROPLET SIZE DISTRIBUTION METER                         E0009   11235
211300
211300 THIS UNIT WILL DETERMINE DROPLET SIZE DISTRIBUTIONS WITHIN A
211300 CHAMBER UTILIZING OPTICAL TECHNIQUES
211300
264650 IR MICROSCOPE                                           EC017   11111
264650
264650 DETERMINE SURFACE TEMPERATURE OF DROPLETS AND ICE CRYSTALS
264650
264650    SENSITIVITY....................+/-0.54F(+/-0.3C) AT 5F (-15C)
264650
    BAUSCH AND LOMB INC            #857-636            $876           111
        OBJECTIVES ...................... 4 FLAT FIELD
        TYPE OBJECTIVES ................. 5X, 0.8 NA; 10X, 0.25NA; 40X,
                                          0.65 NA; 100X, 1.25 NA
        ILLUMINBATOR .................... 5 STEP, LOW VOLTAGE TRANSFORMER
        EYEPIECES ....................... PAIRED 10X

    BAUSCH-LOMB INC.               #MICROSCOPE TYPE II                111
        NUMERICAL APERTURE .............. 0.75
        MEASUREMENT MAGNIFICATION ....... 6X
        OBSERVATION MAGNIFICATION ....... 50X
        EFFECTIVE SLIT LENGTH ........... 12MM
        EFFECTIVE SAMPLE AREA ........... 0.3MMX2MM

    BARNES ENGINEERING CO.         #RM-2A              $7950          111
        READOUT ......................... DIRECT
        TEMP. RESOLUTION ................ 0.5C AT ROOM TEMP.
        DETECTOR ........................ INDIUM ANTIMONIDE
        RESPONSE ........................ 8 MICROSEC.
        VIEWING ......................... SIMULTANEOUS W/MEASUREMENT
        SPECTRAL BANDWIDTH .............. 1.8 TO 5.5 MICRONS
        TEMP.RANGE ...................... SCALE A: 15C TO 65C
                                          SCALE B: 15C TO 165C
                                          SCALE C: 0C TO 350C
                                          OPTIONAL SCALE: TO 1500C
         OBJECTIVE ...................... 0.05X TO 74X

355500 OPTICAL SENSORS                                         E0013  121111
355500
355500 SENSOR FOR CONTROL OF PARTICLE CHARACTERISTICS AND OPTICAL
355500 ENERGY SOURCES
355500
424000 DIGITAL TAPE RECORDER                                   EC086   11111
424000
424000 PROVIDES FOR RECORDING SENSOR DIGITAL OUTPUT DATA.
424000
424000    TAPE SIZE ..................... 1 INCH
424000    TRACKS ........................ 9
424000    TAPE SPEED .................... VARIABLE
424000    DATA RATE ..................... 1.3E+06 BPS
424000    REEL SIZE ..................... 12 INCHES DIA
424000
    AMPEX CORPORATION              #AR-200                            121

        BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                          300 HZ TO 250 KHZ
        TAPE WIDTH ...................... 0.5 INCH
        TAPE SPEED ...................... 1.875 TO 60 IPS
        RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
        FORMAT .......................... DIGITAL
        TRACKS .......................... 9 DIGITAL, 7 ANALOG

    AMPEX CORP                     #AR 1700            $28,000        112
        TRACKS .......................... 14
        TAPE SPEED ...................... 120 IPS
        TAPE WIDTH ...................... 1 INCH
        RECORDING MODE................... DIRECT
        PACKING DENSITY ................. 20 KB/I/T
        SIGNAL/NOISE .................... 20 DB
        DATA CAPACITY ................... 6.2E+10
        BANDWIDTH ....................... 2 MB/SEC/T
        TAPE LENGTH......................9200 FEET
    SANGAMO ELECTRIC               #SABER III          $26,500        111
        TRACKS .......................... 14
        TAPE WIDTH ...................... 1 INCH
        TAPE SPEEDS...................... 8 SELECTABLE SPEEDS FROM 15/16
                                          TO 120 IPS
        FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
        RECORDING RATE .................. 600 KBPS AT 120 IPS SERIAL MODE
        WEIGHT .......................... 100 POUNDS

    DIGI-DATA CORPORATION          #1600               $2650          111
        TAPE SPEED ...................... 25, 18.75, 12.5 IPS
        TRACKS .......................... 7 OR 9 TRACK
        DATA DENSITY .................... 1600 CPI PHASE ENCODED
                                          200, 556, 800 CPI NRZI
        TAPE ............................ 0.5 INCH, 1.5 MIL, 1200 FEET

    DIGI-DATA CORPORATION          #1700/PDP-11/7-9    $5250          111
                                        TRACK NRZI
        TAPE SPEED ...................... 45, 37.5, 25, 18.75, 12.5 IPS
        TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                          COMPATIBLE, 10.5 INCH REEL
        TRACKS .......................... 7 OR 9
        DATA DENSITY .................... PHASE ENCODED
                                          COMPATIBLE
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HEWLETT PACKARD               #7970H/C             $ 4600        111
    TAPE FORMAT ...................... NRZ, 556, 1R 200 CPI NRZI AND
                                       1600 CPI PHASE-ENCODED
    CHANNELS ......................... 7 OR 9
    TAPE SPEED ....................... 10 TO 45 IPS
    TAPE ............................. 0.5 INCH, 1.5 MILS, IBM/ANSI
                                       COMPATIBLE

BORG WARNER                   #PERT                              121
    TRACKS ........................... 30
    TAPE SPEED ....................... UP TO 1000 IPS
    TAPE WIDTH ....................... 1/2 INCH
    TAPE LENGTH ...................... 2400 FEET
    PACKING DENSITY .................. 15 KB/I/T
    SIGNAL/NOISE ..................... 24 DB
    DATA CAPACITY .................... 1.3E+9
    BANDWIDTH ........................ 6-15 MB/SEC/T
LEACH                         #MTR 7000                          311
    TRACKS ........................... 12
    TAPE SPEED ....................... 120 IPS
    TAPE WIDTH ....................... 1 INCH
    TAPE LENGTH....................... 9200 FEET
    PACKING DENSITY................... 16.7 KB/I/T
    SIGNAL/NOISE ..................... 22 DB
    DATA CAPACITY .................... 2.2E+10
    BANDWIDTH ........................ 2 MB/SEC/T

HEWLETT PACKARD               #3955D               $10200        111
    BANDWIDTH ........................ 300 KHZ
    CHANNELS ......................... 7
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD               #3955C               $14700        111
    BANDWIDTH ........................ 300 KHZ
    CHANNELS ......................... 14
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD               #3955CA-011          $23800        111
    BANDWIDTH ........................ 500 HZ TO 2 MHZ
    CHANNELS ......................... 14
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD               #3960A/13065A/13063A $4795         111
    CONFIGURATION .................... RACK MOUNTED
    TAPE SPEED ....................... 15, 3 AND 3/4, 15/16 IPS
    CHANNELS ......................... 4
    RECORDING FORMAT ................. FM
    PASSBAND ......................... 5 KHZ
    S/N RATIO......................... 45 DB
    TRACKS ........................... 30

HONEYWELL                     #5600                $9730
    PORTABLE TAPE RECORDER
    CHANNELS.......................... 7
    SELECTABLE TAPE SPEED RANGE...... 15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)........ 300KHZ
    PACKING DENSITY.................. UP TO 600PBI
    WEIGHT........................... 70LBS (32KG)
    INPUT VOLTAGE....................28VDC
HONEYWELL                     #96                  $17420
    CHANNELS.......................... 7
    SELECTABLE TAPE SPEED RANGE...... 15/16 TO 240IPS
    REEL SIZE........................ 16IN
    MAXIMUM BANDWIDTH(DIRECT)........ 2M HZ
    TAPE WIDTH....................... 1/2 IN

AMPEX CORP                    #AR 700              $29,180       511
    TRACKS ........................... 14
    TAPE SPEED ....................... 60 IPS
    TAPE WIDTH ....................... 1 INCH
    RECORD MODE....................... DIRECT
    PACKING DENSITY .................. 20 KB/I/T
    SIGNAL/NOISE ..................... 20 DB
    DATA CAPACITY .................... 8E+10 BITS
    BANDWIDTH ........................ 1 MB/SEC/T

620070 LIDAR TRANSMITTER                                  EC088   11112
620070
620070 PROVIDES SIGNAL SOURCE TO MEASURE CLOUD HEIGHTS AND AEROSOL DIS-
620070 TRIBUTION.
620070
620070    WAVE LENGTH ..................... 6328 ANGSTROMS
620070    ILLUMINATION MODES .............. RUBY, DOUBLED RUBY, DYE,
620070                                      DOUBLED DYE
620070
018700 RECEIVER, TELESCOPE                                EC089   11112
018700
018700 RECEIVES TRANSMITTER RETURNED SIGNALS.
018700
018700    INSTANTANEOUS FOV ............... 0.0018 RAD
018700    POINTING ACCURACY ............... 0.0087 RAD
018700    POINTING STABILITY .............. 0.0087 RAD
018700    POINTING STABILITY RATE ......... 0.0017 RAD PER SEC
018700    POINTING DURATION ............... 7200 SEC
018700
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424000 DIGITAL RECORDER                                        EC091   11111
424000
424000 PROVIDES FOR RECORDING DIGITAL OUTPUT DATA.
424000
424000    TAPE SIZE ..................... 1 INCH
424000    TRACKS ........................ 9
424000    REEL SIZE ..................... 12 INCHES
424000    TAPE SPEED .................... VARIABLE
424000    DATA RATE...................... 80 MBPS
424000
   AMPEX CORPORATION            #AR-200                                121

      BANDWIDTH ..................... 100 HZ TO 3125 HZ THROUGH
                                      300 HZ TO 250 KHZ
      TAPE WIDTH .................... 0.5 INCH
      TAPE SPEED .................... 1.875 TO 60 IPS
      RECORDING TIME ................ 8 MINUTES TO 4 HRS AND 16 MINS
      FORMAT ........................ DIGITAL
      TRACKS ........................ 8 DIGITAL, 7 ANALOG

   AMPEX CORP                   #AR 1700           $28,000             112
      TRACKS ........................ 14
      TAPE SPEED .................... 120 IPS
      TAPE WIDTH .................... 1 INCH
      RECORDING MODE................. DIRECT
      PACKING DENSITY ............... 20 KB/I/T
      SIGNAL/NOISE .................. 20 DB
      DATA CAPACITY ................. 6.2E+10
      BANDWIDTH ..................... 2 MB/SEC/T
      TAPE LENGTH....................9200 FEET

   SANGAMO ELECTRIC             #SABER III         $26,500             111
      TRACKS ........................ 14
      TAPE WIDTH .................... 1 INCH
      TAPE SPEEDS.................... 8 SELECTABLE SPEEDS FROM 15/16
                                      TO 120 IPS
      FREQUENCY RESPONSE ............ 400 HZ TO 2.0 MHZ
      RECORDING RATE ................ 600 KBPS AT 120 IPS SERIAL MODE
      WEIGHT ........................ 100 POUNDS

   DIGI-DATA CORPORATION        #1600              $2650               111
      TAPE SPEED .................... 25, 18.75, 12.5 IPS
      TRACKS ........................ 7 OR 9 TRACK
      DATA DENSITY .................. 1600 CPI PHASE ENCODED
                                      200, 556, 800 CPI NRZI
      TAPE .......................... 0.5 INCH, 1.5 MIL, 1200 FEET

   DIGI-DATA CORPORATION        #1700/PDP-11/7-9   $5250               111
                                 TRACK NRZI
      TAPE SPEED .................... 45, 37.5, 25, 18.75, 12.5 IPS
      TAPE .......................... 0.5 INCH, 1.5 MIL, IBM/ANSI
                                      COMPATIBLE, 10.5 INCH REEL
      TRACKS ........................ 7 OR 9
      DATA DENSITY .................. PHASE ENCODED
                                      COMPATIBLE

   HEWLETT PACKARD              #7970B/C           $ 4600              111
      TAPE FORMAT ................... 800, 556, OR 200 CPI NRZI AND
                                      1600 CPI PHASE-ENCODED
      CHANNELS ...................... 7 OR 9
      TAPE SPEED .................... 10 TO 45 IPS
      TAPE .......................... 0.5 INCH, 1.5 MILS, IBM/ANSI
                                      COMPATIBLE

   BORG WARNER                  #PERT                                  121
      TRACKS ........................ 30
      TAPE SPEED .................... UP TO 1000 IPS
      TAPE WIDTH .................... 1/2 INCH
      TAPE LENGTH ................... 2400 FEET
      PACKING DENSITY ............... 15 KB/I/T
      SIGNAL/NOISE .................. 24 DB
      DATA CAPACITY ................. 1.3E+9
      BANDWIDTH ..................... 6-15 MB/SEC/T

   LEACH                        #MTR 7000                              311
      TRACKS ........................ 12
      TAPE SPEED .................... 120 IPS
      TAPE WIDTH .................... 1 INCH
      TAPE LENGTH.................... 9200 FEET
      PACKING DENSITY................ 16.7 KB/I/T
      SIGNAL/NOISE .................. 22 DB
      DATA CAPACITY ................. 2.2E+10
      BANDWIDTH ..................... 2 MB/SEC/T

   HEWLETT PACKARD              #3955D             $10200              111
      BANDWIDTH ..................... 300 KHZ
      CHANNELS ...................... 7
      RECORDING FORMAT .............. DIRECT OR FM

   HEWLETT PACKARD              #3955C             $14700              111
      BANDWIDTH ..................... 300 KHZ
      CHANNELS ...................... 14
      RECORDING FORMAT .............. DIRECT OR FM

   HEWLETT PACKARD              #3950A-011         $23900              111
      BANDWIDTH ..................... 500 HZ TO 2 MHZ
      CHANNELS ...................... 14
      RECORDING FORMAT .............. DIRECT OR FM
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HEWLETT PACKARD            #3960A/13065A/13063A $4796        111
     CONFIGURATION ..................... RACK MOUNTED
     TAPE SPEED ........................ 15, 3 AND 3/4, 15/16 IPS
     CHANNELS .......................... 4
     RECORDING FORMAT .................. FM
     PASSBAND .......................... 5 KHZ
     S/N RATIO.......................... 48 DB
     TRACKS ............................ 30

HONEYWELL                  #5600               $9730
     PORTABLE TAPE RECORDER
     CHANNELS........................... 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 60IPS
     MAXIMUM BANDWIDTH(DIRECT)....... 300KHZ
     PACKING DENSITY.................. UP TO 600PBI
     WEIGHT........................... 70LBS (32KG)
     INPUT VOLTAGE.....................28VDC

HONEYWELL                  #96                 $17420
     CHANNELS........................... 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 240IPS
     REEL SIZE.......................... 16IN
     MAXIMUM BANDWIDTH(DIRECT)....... 2M HZ
     TAPE WIDTH......................... 1/2 IN

AMPEX CORP                 #AR 70C             $29,180       511
     TRACKS ............................ 14
     TAPE SPEED ........................ 60 IPS
     TAPE WIDTH ........................ 1 INCH
     RECORD MODE........................ DIRECT
     PACKING DENSITY ................... 20 KB/I/T
     SIGNAL/NOISE ...................... 20 DB
     DATA CAPACITY ..................... 8E+10 BITS
     BANDWIDTH ......................... 1 MB/SEC/T

350500 OSCILLOSCOPE                                   EC096   11111
350500
350500 MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATION.
350500
350500    BANDWIDTH ........................ 100 MHZ
350500    CHANNELS ......................... 2
350500    SENSITIVITY ...................... 10 MV/DIVISION
350500    TIME BASE ........................ VARIABLE
350500    STORAGE CAPABILITY ............... NO
350500
     TEKTRONIX                  #485                $4200         111
       BANDWIDTH.......................... 350 MHZ
       RANGE,CALIBRATED................    5MV/DIV TO 5V/DIV IN 10 STEPS
            UNCALIBRATED................ CONT VAR TO 12.5V/DIV
       RESPONCE TIME......................LESS THAN 1 NS
       CHANNELS........................... 1,ALTERNATE, CHOPPED,ADDED,X-Y
            .............................. CHANNEL 2 (+UP OR INVERTED)
       DIMENSIONS......................... 16.7 X 32.4 X 30.5 CM
       WEIGHT............................. 9.5 KG
       POWER.............................. 115/230V 48-440HZ  60W

     TEKTRONIX INC              #7313/7A18 PLUG-IN/  $4300        111
                                 7B7C PLUG-IN
       BANDWIDTH ......................... DC TO 80 MHZ
       CHANNELS .......................... 2
       DEFLECTION FACTOR ................. 5 MV/DIV TO 5 V/DIV
       TIMEBASE .......................... 2 NS/DIV TO 5 S/DIV
       MAX VIEW TIME ..................... 4 HOURS
       MAX STORED WRITING SPEED ........ 5000 DIV/MS
       TYPE OF STORAGE ................... SPLIT SCREEN BISTABLE

     TEKTRONIX INC              #7904/7A19 PLUG-IN   $6050        111
                                 /7B70 PLUG-IN
       BANDWIDTH ......................... DC TO 500 MHZ
       CHANNELS .......................... 2
       DEFLECTION FACTOR ................. 10 MV/DIV TO 1 V/DIV
       TIMEBASE .......................... 2 NS/DIV TO 5 S/DIV

     TEKTRONIX INC              #R465               $1800         111
       BANDWIDTH ......................... DC TO 100 MHZ
       CHANNELS .......................... 2
       DEFLECTION FACTOR ................. 5 MV/DIV TO 5 V/DIV
       TIME BASE ......................... 0.01 MICROSEC/DIV TO 0.5 S/DIV

018700 TELESCOPE - TRACKING                                  MEC     11135
018700
018700 USED FOR HIGH RESOLUTION VIEWING OF SPECIFIC TARGETS
018700
018700    INSTANTANEOUS FIELD OF VIEW...0.50DEG(124X)
018700                                ...4.00DEG(16X)
018700    FIELD OF VIEW(CROSS-TRACK)....0.50EG AND 4.0DEG
018700    POINTING ANGLE FROM NADIR
018700      (PITCH, ALONG TRACK).........+70 TO -40DEG
018700    POINTING ANGLE FROM NADIR
018700      (ROLL, CROSS TRACK)..........+/-75DEG
018700    TOTAL ANGULAR COVERAGE (CROSS-
018700      TRACK) FROM NADIR (1FOV/2+
018700      POINTING ANGLE)...............+/-75DEG
018700    POINTING ACCURACY (1-SIGMA)...0.1DEG
018700
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622010 VIEWER - WIDE ANGLE                                        MEO     11235
622010
622010 USED FOR LARGE AREA VIEWING AND ORIENTATION. INSTRUMENT SIMILAR
622010 TO THE WILD NF2 NAVIGATION SIGHT USED WITH THE WILD-HEERBRUGG
622010 RC-10 METRIC CAMERA
622010
622010    INSTANTANEOUS FIELD OF VIEW...110DEG X 110DEG
622010                               ...55DEG X 55DEG
622010                               ...28DEG X 28DEG
622010    FIELD OF VIEW.................360DEG IN AZIMUTH
622010    POINTING ANGLE FROM NADIR
622010       (PITCH, ALONG-TRACK)........0 TO 60DEG
622010    TOTAL ANGULAR COVERAGE (CROSS-
622010       TRACK) FROM NADIR (1FOV/2+
622010       POINTING ANGLE).............+/-60DEG
622010    POINTING ACCURACY (1-SIGMA)...2DEG
622010
459700 LONG WAVE INFRARED SPECTROMETER                            MEC     11111
459700
459700 USED FOR IDENTIFICATION OF TYPES OF ROCKS, SOILS AND SEDIMENTS
459700
459700    SPECTRAL RANGE.................0.4 TO 2.4 MICRONS
459700                   ................6.2 TO 15.5 MICRONS
459700    RADIOMETRIC CHANNEL RANGE.....10 TO 12 MICRONS
459700    INSTANTANEOUS FIELD OF VIEW...1 MILLI RADIAN DIA.
459700    POINTING ANGLE FROM NADIR
459700       (PITCH, ALONG TRACK)........+45DEG  TO -10DEG
459700    POINTING ANGLE FROM NADIR
459700       (ROLL, CROSS TRACK).........+/-20DEG
459700    POINTING ACCURACY..............0.3DEG
459700
424000 MAGNETIC TAPE RECORDER                                     MEO     21111
424000
424000 ONBOARD DATA RECORDING OF SCIENTIFIC INSTRUMENT DATA
424000
424000    READ IN RATE..................100MBPS
424000    STORAGE CAPACITY/MISSION......3E12 BITS
424000
   AMPEX CORPORATION              #AR-200                               121

      BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                        300 HZ TO 250 KHZ
      TAPE WIDTH ...................... 0.5 INCH
      TAPE SPEED ...................... 1.875 TO 60 IPS
      RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
      FORMAT .......................... DIGITAL
      TRACKS .......................... 8 DIGITAL, 7 ANALOG

   AMPEX CORP                     #AH 1700          $28,000             112
      TRACKS .......................... 14
      TAPE SPEED ...................... 120 IPS
      TAPE WIDTH ...................... 1 INCH
      RECORDING MODE................... DIRECT
      PACKING DENSITY ................. 20 KB/I/T
      SIGNAL/NOISE .................... 20 DB
      DATA CAPACITY ................... 6.2E+10
      BANDWIDTH ....................... 2 MB/SEC/T
      TAPE LENGTH......................9200 FEET

   SANGAMO ELECTRIC               #SABER III        $26,500             111
      TRACKS .......................... 14
      TAPE WIDTH ...................... 1 INCH
      TAPE SPEEDS...................... 8 SELECTABLE SPEEDS FROM 15/16
                                        TO 120 IPS
      FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
      RECORDING RATE .................. 600 KBPS AT 120 IPS SERIAL MODE
      WEIGHT .......................... 100 POUNDS

   DIGI-DATA CORPORATION          #1600             $2650               111
      TAPE SPEED ...................... 25, 18.75, 12.5 IPS
      TRACKS .......................... 7 OR 9 TRACK
      DATA DENSITY .................... 1600 CPI PHASE ENCODED
                                        200, 556, 800 CPI NRZI
      TAPE ............................ 0.5 INCH, 1.5 MIL, 1200 FEET

   DIGI-DATA CORPORATION          #1700/PDP-11/7-9  $5250               111
                                   TRACK NRZI
      TAPE SPEED ...................... 45, 37.5, 25, 18.75, 12.5 IPS
      TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                        COMPATIBLE, 10.5 INCH REEL
      TRACKS .......................... 7 OR 9
      DATA DENSITY .................... PHASE ENCODED
                                        COMPATIBLE

   HEWLETT PACKARD                #7970B/C          $ 4600              111
      TAPE FORMAT ..................... 800, 556, OR 200 CPI NRZI AND
                                        1600 CPI PHASE-ENCODED
      CHANNELS ........................ 7 OR 9
      TAPE SPEED ...................... 10 TO 45 IPS
      TAPE ............................ 0.5 INCH, 1.5 MILS, IBM/ANSI
                                        COMPATIBLE

   BORG WARNER                    #PERT                                 121
      TRACKS .......................... 30
      TAPE SPEED ...................... UP TO 1000 IPS
      TAPE WIDTH ...................... 1/2 INCH
      TAPE LENGTH ..................... 2400 FEET
      PACKING DENSITY ................. 15 KB/I/T
      SIGNAL/NOISE .................... 24 DB
      DATA CAPACITY ................... 1.3E+9
      BANDWIDTH ....................... 6-15 MB/SEC/T
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LEACH                           #MIR 7C00                              111
     TRACKS ......................... 12
     TAPE SPEED ..................... 120 IPS
     TAPE WIDTH ..................... 1 INCH
     TAPE LENGTH..................... 9200 FEET
     PACKING DENSITY................. 16.7 KB/I/T
     SIGNAL/NOISE ................... 22 DB
     DATA CAPACITY .................. 2.2E+10
     BANDWIDTH ...................... 2 MC/SEC/T

HEWLETT PACKARD                 #3555D               $10200            111
     BANDWIDTH ...................... 300 KHZ
     CHANNELS ....................... 7
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                 #3555C               $14700            111
     BANDWIDTH ...................... 300 KHZ
     CHANNELS ....................... 14
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                 #3550A-011           $23800            111
     BANDWIDTH ...................... 500 HZ TO 2 MHZ
     CHANNELS ....................... 14
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                 #3960A/13065A/13063A $4796             111
     CONFIGURATION .................. RACK MOUNTED
     TAPE SPEED ..................... 15, 3 AND 3/4, 15/16 IPS
     CHANNELS ....................... 4
     RECORDING FORMAT ............... FM
     PASSBAND ....................... 5 KHZ
     S/N RATIO....................... 48 DB
     TRACKS ......................... 30

HONEYWELL                       #5600                $9730
     PORTABLE TAPE RECORDER
     CHANNELS........................ 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 60IPS
     MAXIMUM BANDWIDTH(DIRECT)....... 300KHZ
     PACKING DENSITY................. UP TO 600PBI
     WEIGHT.......................... 70LBS (32KG)
     INPUT VOLTAGE...................28VDC

HONEYWELL                       #96                  $17420
     CHANNELS........................ 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 240IPS
     REEL SIZE....................... 16IN
     MAXIMUM BANDWIDTH(DIRECT)....... 2M HZ
     TAPE WIDTH...................... 1/2 IN

AMPEX CORP                      #AR 700              $29,180           111
     TRACKS ......................... 14
     TAPE SPEED ..................... 60 IPS
     TAPE WIDTH ..................... 1 INCH
     RECORD MODE..................... DIRECT
     PACKING DENSITY ................ 20 KB/I/T
     SIGNAL/NOISE ................... 20 DB
     DATA CAPACITY .................. 8E+10 BITS
     BANDWIDTH ...................... 1 MB/SEC/T

219700 DATA BUFFERS, FORMATTERS                              MEO     21111
219700
219700 BUFFERS DATA FROM HIGH RESOLUTION WIDEBAND MULTISPECTRAL SCANNER
219700
219700     INPUT DATA RATE.................200MBPS
219700     OUTPUT DATA RATE................100MBPS
219700     INPUT DATA DUTY CYCLE...........33%
219700
   RESEARCH INC                 #812-3               $3500             111
     OUTPUT VOLTAGE ................. 5 V FS
     OUTPUT CURRENT ................. 1-5, 4-20, 10-50 MAMP
     OUTPUT IMPEDANCE ............... 1.2 K OHM ON 5 V SCALE
     CONVERSION RESOLUTION .......... 10 BITS
     PERCENT OUTPUT/UPDATE .......... 99.7
     DROOP RATE ..................... 0.1 %/HR
     SETTLING TIME .................. 50 MICROSEC
     UPDATE TIME .................... 2.2 MSEC
     MAX SIG AND HOLD CHANNELS ...... 32
     SIG AND HOLD CHANS PER CARD .... 4

105550 MULTIPLEXER                                           MEO     11111
105550
105550 MULTIPLEX DATA FOR TRANSMISSION VIA SHUTTLE COMMUNICATION LINK
105550
   TENNELEC                     #TC500               $6000             111
     CONVERSION TIME................. 3MICRO SEC
     CAPACITY........................ 2048 CHANNELS
     CONFIGURATION................... COMPATIBLE WITH NIM

   TENNELEC                     #TC 520              $750              111
     CHANNELS........................ 8
     CHANNEL DWELL TIME.............. 300NSEC
     CONFIGURATION................... NIM COMPATIBLE

   RESEARCH INC                 #812-4A              $2630             111
     CODING LINEARITY ............... +/- 0.5 LSB
     ANALOG INPUT ................... -10.240 TO +10.235 V
     INPUT IMPEDANCE ................ 100 MEG OHM
     INPUT OVERVOLTAGE PROTECTION ... +/- 100 V
     FULL SCALE ACCURACY ............ +/- .025 PERCENT
     RESOLUTION ..................... 12 BITS BINARY
     CONVERSION SPEED ............... 5 KHZ
     LOGIC LEVELS
          LOGIC 0 ................... 5 +/- 1.5 V
          LOGIC 1 ................... 0 V + .4V, - .0V
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    ANALOGIC CORP                     #AN4716-8A          $275          111
        SINGLE ENDED CHANNELS ........... 16
        DIFFERENTIAL CHANNELS ........... 8
        CMRR ............................ 80 DB AT 1000 MHZ

    ROHDE AND SCHWARZ                 #UCM 210/1                        111
                                       (221.5603.02)
        ANALOG INPUT RANGE .............. +12 TO -12 VOLTS
        SAMPLING RATE ................... > 10000 MEAS/SEC (POSITIVE)
                                          > 17000 MEAS/SEC (NEGATIVE)
        DATA OUTPUT ..................... 3+1 DECADES (BCD CODE PARALLEL)
                                          0-1200 PULSES (SERIAL)

104180 CRT DISPLAY                                              MED     61111
104180
104180 TWO CRT'S ARE LOCATED IN THREE CONSOLES FOR DATA DISPLAY OF
104180 ALPHANUMERICS AND GRAPHICS.
104180
104180      RESOLUTION.....................1000 LINES
104180      CONTROL INPUT FORM.............DIGITAL
104180      SCAN...........................RASTER
104180          ...........................CONICAL
104180      PHOSPHOR CHARACTERISTICS.......FOUR-COLOR PENETRATION
104180      SCREEN SIZE....................16IN (40CM)
104180      CONTRAST.......................8 GRAY LEVELS
104180
    RESEARCH INC                      #3300               $1560
        FORMAT...............................24 LINESX72 OR 80 CHARACTERS
              ...............................24 LINESX40 CHARACTERS
              .......... ................... 12 LINESX72 OR 80 CHARACTERS
        REFRESH RATE.........................60 HZ
        TRANSFER RATE........................110 TO 2400 BAUD
        CHARACTER FORM.......................5X7 DOT MATRIX
        DIMENSIONS...........................15-1/2WX13-1/2HX23-1/2D INCH
        WEIGHT...............................39LB (17.7KG)

    TEKTRONIX INC                     #4C02A              $10975        111
        DISPLAY MEDIUM ............ 11 IN DIA CRT
        DISPLAY AREA .............. 8.3IN.HOR.X6.1IN.VERT.
        ALPHANUMERIC MODE:
          FORMAT .................. 39LINES OF 85 NORMAL CHARACT.
          CHARACTER SET ........... 96 UPPER & LOWER CASE
          CHARACTER SIZE .......... 70X90MILS(CAN BE TWICE SIZE)
          CHARACTER GENERATION .... 7X9 DOT MATRIX
          CURSOR .................. PULSATING 7X9 MATRIX
        GRAPHIC MODES ............. LINEAR INTERPOLATE,INCREMENTAL
                                    PLOT,POINT PLOT,1024X1024 AD-
                                    DRESSABLE POINTS,1024X761 VIEW-
                                    ABLE POINTS
          GRAPHIC INPUT MODE ...... 1024(X),761(Y),JOYSTICK CONTROLLED,
                                    CROSSHAIR CURSOR
        ACCUMULATORS .............. 4
        CYCLE TIME ................ 300 NANOSEC
        CORE MEMORY ............... 32 K

164000 MICROFICHE READER                                        MED     11111
164000
164000 READER CONCURRENTLY DISPLAYS SEQUENCES OF MICROFILM RECORDS OF
164000 MAPS, REFERENCE SIGNATURES AND OTHER MATERIALS NEEDED FOR
164000 REAL TIME EVALUATION OF SENSOR FORMATS SELECTED FOR CRT DISPLAY
164000
164000      STORAGE CAPACITY...............73,000PAGES
164000      RETRIEVAL SPEED................6 SECONDS MAX
164000      INTERFACE......................STANDARD COMPUTER
164000
    CALMA CO.                         #3C3M               $28000        111
        FUNCTION ........................ OFF LINE DIGITIZING SYSTEM
                                          WITH FILM PROJECTION.
                                          PROVIDES CAPABILITY OF
                                          DIGITIZING FILM DATA

101340 MULTIFUNCTION KEYBOARD                                   MED     31111
101340
101340 CONSOLE CONTROL KEYBOARD WITH FUNCTION KEYS LABELLED BY COMPUTER.
101340 A SUPPORTING SOFTWARE LOGIC TREE FOR DATA ENTRY AND DISPLAY CALL
101340 UP CAN BE ENTER AT ANY LEVEL.
101340
    BUNKER-RAMO CORP                  #2200               $440          111
        KEYS ............................ TYPEWRITER SET STD
        PROGRAM ASSIST KEYS ............. 16
        INTERFACE ....................... CRT
        EDITING KEYS .................... FULL SET

102750 OPERATIONS CONTROL COMPUTER                              MED     11111
102750
102750 THE COMPUTER SHALL PROVIDE THE FOLLOWING FUNCTIONS: COMMAND
102750 INTERPRETATION AND EXECUTION, ATTITUDE AND POINTING PROGRAM
102750 CONTROL AND COMPUTATION AND DATA MANAGEMENT SEQUENCING OPERATIONS
102750
102750      MEMORY SIZE....................14550 WORDS
102750      ADD/MULT EXECUTE TIME..........5/30 MICRO SECONDS
102750
    VARIAN DATA MACHINES              #520/I                            111
        MEMORY CYCLE TIME ............... 1.5MICROSEC.
        MEMORY .......................... EXPANDABLE,4096BYTES(8BITS)TO
                                          32,768BYTES
        REGISTERS ....................... 12
        OPERAND PRECISION ............... UP TO 32 BITS
        ADDRESS REFERENCE ............... 8,16,24,OR 32 BIT LEVEL
        NOTE:                             HAS FULL RANGE INTERFACE
                                          HARDWARE
```

ORIGINAL PAGE IS OF POOR QUALITY

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VARIAN DATA MACHINES          #5-620/I                            111
     BASIC COMMANDS  ................. OVER 100
     ADDRESSING MODES  ............... 6
     MAX.WORDS  ...................... 32,768
     WORD LENGTH  .................... 16 OR 18 BIT
     REGISTERS  ...................... 9
     NOTE:                             HAS FULL RANGE INTERFACE
                                       HARDWARE

CLARY DATACOMP SYSTEMS INC     #404                               111
     SIMULTANEOUS TERMINALS ......... 16
     INPUT ........................... TELETYPEWRITER KEYBOARD
     ACCUMULATOR ..................... 64 BIT
     REGISTERS ....................... 16 BIT INDEX (2 EACH)
     WORD LENGTH ..................... 16, 32, 48, 64 BITS
     MEMORY CAPACITY ................. 1024 16 BIT WORDS, 4096 16 BIT
                                       WORDS,OR ADDITIONAL 4096 16 BIT
                                       WORDS. TOTAL 65538 WORDS
GENERAL AUTOMATION INC.        #18-30                             111
     FUNCTION ........................ SUPERVISE SMALLER COMPUTERS
     MEMORY........................... 8K CORE
     CYCLE TIME ...................... 1.2 MICROSEC.

GENERAL AUTOMATION INC.        #SPC-16                            111
     MEMORY .......................... 16K
     WORD LENGTH ..................... 16 BITS
     READ/WRITE CYCLE MEMORY TIME ... 800 TO 1440 NANOSEC.
     READ ONLY MEMORY ................ 400 TO 720 NANOSEC.
     INPUT/OUTPUT TIME ............... 1.6 TO 2.8 MICROSEC.
     DMA TRANSFER RATE ............... 0.694E+06 TO 2.5E+06

GENERAL AUTOMATION INC.        #SPC-12                            111
     MEMORY .......................... 4K TO 16K
     WORD LENGTH ..................... 8 BITS
     CYCLE TIME ...................... 2.16 MICROSEC
     STORED PROGRAM EXECUTION RATE .. 0.23E+06/SEC
     I/O TRANSFER RATE ............... 0.46E+06/SEC
     REGISTERS ....................... 6 12 BIT REGISTERS
     ACCUMULATORS .................... 4 12 BIT

DIGITAL EQUIPMENT CORP         #PDP-8/E            $22000         111
DIGITAL EQUIPMENT CORP         #PDP-8/I                           111
     MEMORY .......................... 4096(CORE)EXPANDABLE TO
                                       32,768 WORDS
     WORD ............................ 12 BIT
     CYCLE TIME ...................... 1.5 MICROSEC.

DATA GENERAL CORP              #NOVA 800           $18450         111
     WORD LENGTH ..................... 16 BIT
     CYCLE TIME ...................... 800 NANOSEC.
     CORE MEMORY ..................... 32K MAX

DATA GENERAL CORP              #SUPERNOVA SC       $5500
     WORD LENGTH ..................... 16 BIT

DATA GENERAL CORP              #NOVA 1200          $11900
     WORD LENGTH ..................... 16 BIT
     CYCLE TIME ...................... 1200 NANOSEC.
     CORE MEMORY ..................... 32K MAX.
```

EARTH AND OCEAN PHYSICS

```
055055 FILM RECORDER                                          OP002    61121
055055
055055 PROVIDE PHOTOGRAPHIC RECORDINGS TC PROVIDE ALL WEATHER STEREO
055055 IMAGERY FOR TOPOGRAPHIC MAPPING, 3-D STRAIN FIELDS, EROSICN, VOL-
055055 CANIC MOTION AND POST-GLACIAL UPLIFT.
055055
055055    FILM TYPE ..................... 70 MM
055055    FILM RATE ..................... 6 MM/SEC
055055    INSTANTANEOUS FOV ............. 0.088 RAD
055055
    WESTINGHOUSE DEFENSE/SPACE    #APQ-97&ASS.EQUIP.                      322
       NOTE:                                SUBSYSTEMS PROCESSOR
                                            & FILM RECORDER CNLY

603002 MULTIFREQUENCY PROPAGATION RECEIVER/PROCESSOR          OP004    11134
603002 & ANTENNA SYSTEM CONTROL UNIT
603002
624010 MULTISPECTRAL SCANNER ELECTRONICS PACKAGE              OP006    11134
624010
603002 IR TEMPERATURE PROFILE RADIOMETER CONTROL UNIT         OP018    11134
603002
603002 CAMERA CONTROL                                         OP020    11134
603002
603002 GIMBAL CONTROL                                         OP020    11134
603002
603002 OPTICAL MONITOR CONTROL                                OP021    11134
603002
603002 CONTAMINATION MONITOR GUAGE CONTROL                    OP021    11134
603002
603002 MASS SPECTROMETER CONTROL                              OP021    11134
603002
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    FAC? PROCESSING APPLICATIONS

606001 FLUID SUPPLY SYSTEM                                  SP001   11134
606001
606001 THIS UNIT CONSISTS OF THREE ELEMENTS SUPPORTING ALL MATERIAL
606001 SCIENCE AND MANUFACTURING EXPERIMENTS. IT IS PART OF THE  CORE
606001 SUBELEMENT PRESENT ON ALL MS/MS PAYLOADS. THE THREE ELEMENTS
606001 ARE AN INERT GAS UNIT, AN OXIDIZING GAS UNIT, AND A REDUCING
606001 GAS UNIT.
606001
498300 DIGITAL CLOCK                                        SP001   11111
498300
498300 DIGITAL TIME DISPLAY. PART OF DIGITAL PROCESS PROGRAMMER ASSY
498300
498300    DISPLAY ......................... 4 DIGITS
498300    DISPLAY TYPE .................... LED
498300
    ROHDE AND SCHWARTZ          #CAD (100.6597.91)   $5400          111
        DISPLAY ........................... 6 DIGITS: HR, MIN, SEC
        OUTPUT ............................ 1-OUT-OF-N AND/OR BCD CODE

    ROHDE AND SCHWARTZ          #MS 6284(110.3226.21)   $12,700     111
        DISPLAY ........................... 9 DIGITS: DAY, HR, MIN, SEC

    DATATRON                    #3350              $1020            111
        INPUT FREQUENCY.................... 60HZ
        OUTPUTS............................ VISUAL, BCD
        DISPLAY............................ HRS,MIN, SEC

    DATATRON                    3030               $7940            111
        CHANNELS........................... 32
        TIMING RANGE....................... 5NANOSEC TO 5MICROSEC
        RESOLUTION......................... 10E-8

104200 SCANNER PROGRAMMER                                   SP001   11111
104200
104200 TRACES COMPLEX FUNCTION  AND TRANSLATES  IT  INTO A SIGNAL WHICH
104200 DRIVES EXPERIMENT CONTROLLER
104200
104200    ACCURACY.........................+-0.5% OF SPAN
104200    REPEATABILITY....................+-0.1 OF SPAN
104200
    RESEARCH INC                #5300              $950             111
        FACE-FOLLOWING ACCURACY
            STATIC ........................ +/- 0.25 PERCENT OF SCAN
            DYNAMIC ....................... +/- 0.25 PERCENT STATIC TO +/-
                                            0.75 PERCENT AT MAX SLEW VEL
        FACE-FOLLOWING REPEATABILITY ...... +/- 0.05 PERCENT OF SCAN
        PROB DEADBAND ..................... +/- 0.025 MM
        FACE-FOLLOWING RESOLUTION ......... WILL RESOLVE SQUARE WAVES WITH
                                            PLOTTED TIME-DURATION EQUAL TO
                                            0.7 PERCENT OF TIME AXIS
        PROGRAM CARD ...................... 5X8 IN MYLAR BASE CONDUCTIVE
                                            COATED CARD

603003 SIGNAL CONDITIONER                                   SP001   11111
603003
603003 AMPLIFIES AND CONDITIONS LOW LEVEL ANALOG SIGNALS AS PART OF
603003 DATA ACQUISITION UNIT
603003
603003    CAPACITY.........................UP TO 33 PAIRS OF SIGNAL WIRES
603003    OUTPUT VOLTAGE...................+-10V
603003    OUTPUT CURRENT...................+- 5MA
603003
    HEWLETT PACKARD             #461A              $380             111
        FREQUENCY RANGE ................... 1 KHZ TO 150 MHZ
        FREQUENCY RESPONSE ................ +/- 1 DB INTO 50 OHM LOAD
        GAIN AT 500 KHZ ................... 40 DB +/- 0.5 DB OR 20 +/- 1 DB
        MAX INPUT ......................... 1 V RMS OR 2 V P-P PULSE

    TENNELEC              #TC 202/203       $355/495                 111
        GAIN............................... 2.5 TO 3000X
        NON LINEARITY...................... LESS THAN 0.05%
        CONFIGURATION...................... NIM COMPATIBLE

    ROHDE AND SCHWARZ           #ATN (100.0899.02)                  111
        FREQUENCY RANGE ................... 30 HZ TO 20 KHZ
        INPUT VOLTAGE ..................... 0.25 - 25 VOLTS
        MAX POWER ......................... 50 WATTS

    RESEARCH INC                #512-11-17         $3200            111
        CAPACITY .......................... TO 33 PAIRS OF SIG WIRES (16GA)
        REFERENCE TEMP .................... HEAT SINK CONTROLLED TO +/- .08
                                            DEG C AT 65 DEG C
        AMBIENT TEMP ...................... 0 TO 49 DEG C
        LEAKAGE RESISTANCE ................ 1000 MEG OHM
        HEAT-UP TIME FROM 22 DEG C ........ 50 MINUTES
        SETTLING TIME ..................... 8 MS TO FINAL VALUE

    HONEYWELL                   #ACCUDATA 117      $1340            111
        MULTICHANNEL WIDEBAND AMPLIFIER
        CHANNELS........................... 7
        MOUNT.............................. BENCH
    HONEYWELL                   #ACCUDATA 115      $5370            111
        HIGH VOLTAGE DC AMPLIFIER
        INPUT SIGNAL VOLTAGE............... +/-50MV TO 1500V
        OUTPUT SIGNAL VOLTAGE.............. UP TO 2000V
        CHANNELS........................... 6
```

```
     NEFF                              #122-222            $610          111
          GAIN..............................1 TO 2500
          COMMON MODE REJECTION........... 140DB
          DRIFT........................... 0.5MICROVOLT/OC
          STEP GAIN ACCURACY.............. +/-0.01%
          SWITCH SELECTABLE FILTER
          BANDWIDTH....................... 100KHZ
          RACK/MODULE MOUNT

     NEFF                              #126-621            $320          111
          AMPLIFIER MULTIPLEXER
          EMPLOYES FET SWITCH
          GAIN RANGE...................... 0.2 TO 2500
          COMMON MODE REJECTION........... 120DB
          OUTPUT.......................... +/-10V AT 10 MILLIAMPERES

     NEFF                              #127-102            $1150         111
          PROGRAMMABLE GAIN WITH SWITCH SELECTABLE OUTPUT FILTER
          GAIN STEPS...................... 1, 2, 5, 10, 20, 50, 100, 200,
                                           500,1000
          COMMON MODE REJECTION........... 140DB
          FET SWITCHING
          RACL/MODULE CONFIGURATION

     TENNELEC                          #TC133              $295          111
          FET PREAMPLIFIER
          CHARGE SENSITIVITY.............. 10E12 VOLTS/COULOMB
          INPUT........................... NEGATIVE INPUT PULSE POLARITY
                                           WITH INPUT CAPACITANCE >2000PF
          OUTPUT.......................... POSITIVE OUTPUT PULSE POLARITY
                                          WITH OUTPUT IMPEDANCE 50 OHM
          STABILITY....................... 0.5%/V

532000 DIGITAL VOLTMETER                                       SP001    11111
532000
532000 VOLTMETER FOR DATA ACQUISITION AND CONTROL UNIT
532000
532000     DC VOLT RANGE............  100MV TO  100V
532000     AC VOLT RANGE............  100MV TO   10V
532000     RESOLUTION...............   0.1% FULL SCALE
532000     ACCURACY................. +-0.5%+-1 DIGIT
532000
     JOHN FLUKE MFG CO INC             #8125A              $1845         311
          VOLTAGE RANGE .................. +/- 1 V TO +/- 1000 V DC
                                           1 V TO 1000 V AC
          RESOLUTION ..................... +/- 0.01%
          FREQUENCY RANGE ................ DC, 30 HZ TO 20 KHZ

     JOHN FLUKE MFG CO INC             #8425A-01           $5995         311
          VOLTACE RANGE .................. +1- 0.1 TO +/- 1000 V DC
                                           1 TO 1000 V AC
          RESOLUTION ..................... 0.001%
          FREQUENCY RANGE ................ DC, 10 HZ TO 100 KHZ

     HONEYWELL                         #VT-100-4           $320          111
          DC RANGE ....................... 100 MV, 1 V, 10 V, 100 V
          AC RANGE ....................... 100 MV, 1 V, 10 V
          RESOLUTION ..................... 0.1 PCT FS
          ACCURACY ....................... +/- 0.2 PCT +/- 1 DIGIT (10 V,
                                           100 V DC SCALES): +/- 0.5 PCT
                                           +/- 1 DIGIT (ALL OTHERS)
          OVERRANGE ...................... 100 PCT

603002 SET POINT CONTROLLER                                    SP001    11111
603002
603002 ESTABLISHES CONTROLLER SET POINT.  SET POINT CAN BE VARIED
603002 FROM PRE-PROGRAMMED INPUT
603002
603002      SIGNAL INPUT.................C - 50MV
603002     DATA OUTPUT...................1 - 50MA,  0 - 5 VDC
603002
     RESEARCH INC                      #R12-6A-64          $2500         111
          SIGNAL INPUT ................... 0 - 50 MV
          BACKUP AMPLIFIER CARDS ......... 16 CARDS, 4 CHANNELS/CARD
          TOTAL BACKUP CHANNELS/MODULE ... 64
          SET POINT ADJUST ............... .05 PCT PER STEP
          WATCHDOG TRANSFER SIGNAL ....... 3-5 V (HOLDING VOLTAGE)
                                           0 V (TRANSFER VOLTAGE)

102700 DIGITAL PROCESS PROGRAMMER                              SP001    11111
102700
102700     PERFORM PREDETERMINED LOGIC ROUTINES SUCH AS EVENT SEQUENCING,
102700     PARAMETER COMMANDS OR REAL TIME SEQUENCING.
102700
103520 INPUT/OUTPUT STACE                                      SP001    11111
103520
103520 THE INPUT/OUTPUT UNIT, THROUGH THE USE OF PLUG IN CORDS, CAN
103520 ACCOMODATE A WIDE RANGE OF PROCESS INPUTS AND OUTPUTS FOR MAXIMUM
103520 CONTROL VERSATILITY.
103520
103520     LOGIC LEVELS, LOGICAL "0"..... 0V
103520                   LOGICAL"1"...... 5V
103520     SIGNAL INPUTS..................COMPATIBLE WITH PDP8 TYPE
103520                                    COMPUTERS
103520     SIGNAL OUTPUTS................ 0 - 5V
103520     DATA OUTPUTS..................12 BIT PARALLEL
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1?? ?
    ANALOGIC CORP                   #MP/9138/14A,        $3??3          111
                                     /15M
        DIGITAL OUTPUT COMP ............ DTL/TTL PARALLEL AND SERIAL
        MONOTONICITY ................... GUARANTEED
        QUANTIZING ERROR ............... +/- 0.5 LSB
        RESOLUTION ..................... 8 TO 16 BITS

    ANALOGIC CORP                   #AN7200              $1500          111
        RECALIBRATION .................. 6 MONTHS
        TEMPERATURE RANGE .............. 0 TO 70 C
        CONVERSION ACCURACY ............ 0.01% FS (+1- 10 V)
        RESOLUTION ..................... 8 THRU 14 BINARY BITS
                                         2, 3, OR 4 BCD DIGITS
        DATA INPUTS .................... DTL/TTL POSITIVE TRUE LOGIC ONE
                                         LOAD/LINE
        DATA ........................... UP TO 16 LINES (14 BINARY BITS
                                         OR 4 BCD DIGITS)
        ADDRESS ........................ 6 CHANNELS - 3 BITS
                                         24 CHANNELS - 5 BITS

101340 CONTROL UNIT - OPERATOR                                SP001   11111
101340
101340 THE OPERATOR'S CONTROL PANEL WILL HAVE THE CAPABILITY OF
101340 CONTROLLING ABOUT 1000 PROCESS LOOPS. DATA MUST BE READOUT ON A
101340 QUICK-LOOK BASIS. IT MUST PROVIDE A WAY TO ENTER NEW PARAMETERS
101340
101340    CHANNEL NUMBER..................3 DIGIT NIXIE(2 EACH)
101340    DATA LEVEL......................4 DIGIT NIXIE PLUS SIGN(2 EACH)
101340    LOGIC LEVELS, LOGICAL"0".......0V
101340                  LOGICAL"1".......5V
101340    DATA OUTPUT.....................VARIABLE
101340
    RESEARCH INC                    #DPS-812             $21,700        111
        COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
        DEC-PDP8-F MINI-COMPUTER, #3301 OPERATIONS CONTROL CONSOLE,
        PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
        CHANNELS ....................... 32
        MEMORY SIZE .................... 8K WORDS

    RESEARCH INC                    #812-1               $2800          111
        LOGIC LEVELS ................... 0 V (LOGIC 0)
                                         5 V (LOGIC 1)
        SIGNAL INPUTS .................. COMPATIBLE PDP8 TYPE COMPUTER
        SIGNAL OUTPUTS ................. STANDARD ZERO AND 5 V OUTPUT
        INTERRUPTS ..................... 12 LEVEL HARDWARE
        INTERVAL TIMES ................. 1 MICROSEC TO 255 SEC ELAPSED
                                         TIME COUNTER
        CLOCK CRYSTAL FREQUENCY ........ 100 KHZ
        BUFFER CARD LOCATIONS .......... 11
        CHANNELS........................ 23

    RESEARCH INC                    #812-2               $2400          111
        CHANNEL NUMBER ................. 3 DIGIT NIXIE (2 EACH)
        DATA LEVEL ..................... 4 DIGIT NIXIE PLUS SIGN(2 EACH)
        SYSTEM STATUS .................. 30 DUAL LAMP ANNUNCIATORS
        ENGINEERING UNITS .............. 10 DUAL LAMP ANNUNCIATORS
        CONTROL PARAMETERS ............. 10 DUAL LAMP ANNUNCIATORS
        LOGIC LEVELS ................... 0 V (LOGIC 0)
                                         5 V (LOGIC 1)

104160 PRINTER                                                SP001   11111
104160
104160 PRINT RECORDED DATA IN THE FORM OF ALPHA-NUMERIC CHARACTERS
104160 IN HARD COPY FORM UPON REQUEST BY OPERATOR.
104160
104160    FORMAT ....................... PICA TYPE - STANDARD
104160                                   CHARACTERS, NUMBERS SYMBOLS
104160
    TEK TRONIX INC                  #4601                $3750          111
        COPY SIZE ...................... 8.5 X 11 INCH
        COPY TIME ...................... 18 SECONDS
        RESOLUTION ..................... 4000 CHARACTER DISPLAY BASED ON
                                         A 90 X 70 MIL MATRIX

    VERSATEC                        #1150P                              112
        FONT............................ 7X9 DOT MATRIX (GOTHIC)
        CHARACTERS/LINE................. 132
        CHARACTER SPACING............... 12.5/IN
        LINE SPACING.................... 6.6 PER IN
        SPEED........................... 500 LINES/MINUTE
        WRITING METHOD.................. ELECTROSTATIC

104180 TELEPRINTER                                            SP001   11111
104180
104180 CHARACTER ORIENTED CRT TERMINAL. DATA IN THE LINE MEMORY IS
104180 CONVERTED, BY THE CHARACTER GENERATOR, INTO THE APPROPRIATE DOT
104180 PATTERN. THE DOTS ARE SHIFTED OUT OF THE SHIFT REGISTER TO FORM
104180 A VIDEO SIGNAL TO THE MONITOR.
104180
104180    SCREEN FORMATS.................40,72 OR 80 CHARACTERS PER LINE
104180           ........................12 OR 24 LINES
104180    TRANSFER RATE..................110 TO 2400 BAUD, 10 OR 11 BIT
104180                                   CHARACTERS
104180    MODES..........................HALF OR FULL DUPLEX
104180
    VARIAN DATA MACHINES            #ASR 33 & ASR 35                    111
        SPEED .......................... 10 CHARACTERS/SEC.
        PAPER .......................... CONTINUOUS ROLL 8.5IN WIDE
        TYPING LINE .................... 85 CHARACTERS
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RESEARCH INC                    #812-3301           $1555         111
    SCREEN FORMATS .................. 22 LINES X 72 OR 80 CHARACTERS
                                      24 LINES X 40 CHARACTERS
    CHARACTER FORM .................. 5 X 7 DOT MATRIX
    TRANSFER RATE ................... 110 TO 2400 BAUD, 10 OR 11 BIT
                                      CHARACTERS
    MODES ........................... HALF OR FULL DUPLEX-SWITCHABLE
                                      LOCAL OR REMOTE

BUNKER-RAMO CORP                #2217-12CRT         $950          111
    CHARACTER RATE .................. 240 PER SEC
    CHARACTER CAPACITY (MAX) ........ 960
    CHARACTERS/LINE (MAX) ........... 80
    LINES/DISPLAY (MAX) ............. 24
    CHARACTERS REPERTOIRE ........... 62 OR 92
    VIEWING AREA .................... 9.75 X 6.25
    REFRESH AREA .................... 54 FRAMES/SEC
    CHARACTER GENERATING METHOD .... 5X7 DOT MATRIX

AN/GCC                          #46                               112

423000 DIGITAL TAPE RECORDER                             SP001   11111
423000
423000 PROVIDE DATA STORAGE FOR DIGITAL PROCESS PROGRAMMER
423000
423000    CHANNELS.......................15
423000
   AMPEX CORPORATION            #AR-200                           121

    BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                      300 HZ TO 250 KHZ
    TAPE WIDTH ...................... 0.5 INCH
    TAPE SPEED ...................... 1.875 TO 60 IPS
    RECORDING TIME .................. 3 MINUTES TO 4 HRS AND 16 MINS
    FORMAT .......................... DIGITAL
    TRACKS .......................... 8 DIGITAL, 7 ANALOG

AMPEX CORP                      #AR 1700            $28,000       112
    TRACKS .......................... 14
    TAPE SPEED ...................... 120 IPS
    TAPE WIDTH ...................... 1 INCH
    RECORDING MODE................... DIRECT
    PACKING DENSITY ................. 20 KB/I/T
    SIGNAL/NOISE .................... 20 DB
    DATA CAPACITY ................... 6.2E+10
    BANDWIDTH ....................... 2 MB/SEC/T
    TAPE LENGTH.......................9200 FEET

SANGAMO ELECTRIC                #SABER III          $26,500       111
    TRACKS .......................... 14
    TAPE WIDTH ...................... 1 INCH
    TAPE SPEEDS...................... 8 SELECTABLE SPEEDS FROM 15/16
                                      TO 120 IPS
    FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
    RECORDING RATE .................. 600 KBPS AT 120 IPS SERIAL MODE
    WEIGHT .......................... 100 POUNDS

DIGI-DATA CORPORATION           #1600               $2650         111
    TAPE SPEED ...................... 25, 18.75, 12.5 IPS
    TRACKS .......................... 7 OR 9 TRACK
    DATA DENSITY .................... 1600 CPI PHASE ENCODED
                                      200, 556, 800 CPI NRZI
    TAPE ............................ 0.5 INCH, 1.5 MIL, 1200 FEET

DIGI-DATA CORPORATION           #1700/PDP-11/7-9    $5250         111
                                 TRACK NRZI
    TAPE SPEED ...................... 45, 37.5, 25, 18.75, 12.5 IPS
    TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                      COMPATIBLE, 10.5 INCH REEL
    TRACKS .......................... 7 OR 9
    DATA DENSITY .................... PHASE ENCODED
                                      COMPATIBLE

HEWLETT PACKARD                 #79708/C            $ 4600        111
    TAPE FORMAT ..................... 800, 556, OR 200 CPI NRZI AND
                                      1600 CPI PHASE-ENCODED
    CHANNELS ........................ 7 OR 9
    TAPE SPEED ...................... 10 TO 45 IPS
    TAPE ............................ 0.5 INCH, 1.5 MILS, IBM/ANSI
                                      COMPATIBLE

BORG WARNER                     #PERT                             121
    TRACKS .......................... 30
    TAPE SPEED ...................... UP TO 1000 IPS
    TAPE WIDTH ...................... 1/2 INCH
    TAPE LENGTH ..................... 2400 FEET
    PACKING DENSITY ................. 15 KB/I/T
    SIGNAL/NOISE .................... 24 DB
    DATA CAPACITY ................... 1.3E+9
    BANDWIDTH ....................... 6-15 MB/SEC/T

LEACH                           #MTR 7000                         311
    TRACKS .......................... 12
    TAPE SPEED ...................... 120 IPS
    TAPE WIDTH ...................... 1 INCH
    TAPE LENGTH...................... 9200 FEET
    PACKING DENSITY.................. 16.7 KB/I/T
    SIGNAL/NOISE .................... 22 DB
    DATA CAPACITY ................... 2.2E+10
    BANDWIDTH ....................... 2 MB/SEC/T
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   HEWLETT PACKARD                  #3555D               $10200          111
        BANDWIDTH ......................... 300 KHZ
        CHANNELS .......................... 7
        RECORDING FORMAT .................. DIRECT OR FM

   HEWLETT PACKARD                  #3555C               $14700          111
        BANDWIDTH ......................... 300 KHZ
        CHANNELS .......................... 14
        RECORDING FORMAT .................. DIRECT OR FM

   HEWLETT PACKARD                  #3550A-011           $23830          111
        BANDWIDTH ......................... 500 HZ TO 2 MHZ
        CHANNELS .......................... 14
        RECORDING FORMAT .................. DIRECT OR FM

   HEWLETT PACKARD                  #3560A/13065A/13063A $4795           111
        CONFIGURATION ..................... RACK MOUNTED
        TAPE SPEED ........................ 15, 3 AND 3/4, 15/16 IPS
        CHANNELS .......................... 4
        RECORDING FORMAT .................. FM
        PASSBAND .......................... 5 KHZ
        S/N RATIO.......................... 48 DB
        TRACKS ............................ 30

   HONEYWELL                        #5600                 $9730
        PORTABLE TAPE RECORDER
        CHANNELS........................... 7
        SELECTABLE TAPE SPEED RANGE........ 15/16 TO 60IPS
        MAXIMUM BANDWIDTH(DIRECT).......... 300KHZ
        PACKING DENSITY.................... UP TO 600PBI
        WEIGHT............................. 70LBS (32KG)
        INPUT VOLTAGE.......................28VDC

   HONEYWELL                        #96                  $17420
        CHANNELS........................... 7
        SELECTABLE TAPE SPEED RANGE........ 15/16 TO 240IPS
        REEL SIZE.......................... 16IN
        MAXIMUM BANDWIDTH(DIRECT).......... 2M HZ
        TAPE WIDTH......................... 1/2 IN
   AMPEX CORP                       #AF 700              $29,180         511
        TRACKS ............................ 14
        TAPE SPEED ........................ 60 IPS
        TAPE WIDTH ........................ 1 INCH
        RECORD MODE........................ DIRECT
        PACKING DENSITY ................... 20 KB/I/T
        SIGNAL/NOISE ...................... 20 DB
        DATA CAPACITY ..................... 8E+10 BITS
        BANDWIDTH ......................... 1 MB/SEC/T

603001 ANALOG (SCR) CONTROLLER                                SP001   11111
603001
603001 SILICON CONTROL RECTIFIER EMPLOYED AS A RELAY SWITCH
603001
603001     LOGIC LEVELS, LOGICAL"0".......0 - 0.6V
603001                   LOGICAL"1".......3.0 - 5.0V
603001     RANGE OF CONTROL...............0 - 100% IN 1 CYCLE INCREMENTS
603001
    RESEARCH INC.                   #ISOSWITCH           $100            111
        ONE REQUIRED PER CHANNEL

   RESEARCH INC                     #N1PC                $2800           111
        LOGIC LEVELS ...................... 0-0.6 V (LOGIC 0)
                                            3.0-5.0 V (LOGIC 1)
        AMBIENT TEMP RANGE ................ 4 - 43 DEG C
        RANGE OF CONTROL .................. 0 - 100 PCT IN 1 CYC INCREMENTS

103500 MULTIPLEXER A/D CONVERTER                              SP001   11111
103500
103500 CONVERT INPUT SIGNAL FRO ANALOG TO DIGITAL FORMAT FOR I/O UNIT
103500
103500     ANALOG INPUT..............   -10.24  TO +10.235V
103500     FULL SCALE ACCURACY.......   +-0.025
103500     RESOLUTION................    12 BITS BINARY
103500     CONVERSION SPEED............. 8 KHZ
103500     DATA OUTPUT.................. 2'S COMPLEMENT
103500
   ANALOGIC CORP                    #MP2913A/14A,        $3080           111
                                     /15M
        DIGITAL OUTPUT COMP ............... DTL/TTL PARALLEL AND SERIAL
        MONOTONICITY ...................... GUARANTEED
        QUANTIZING ERROR .................. +/- 0.5 LSB
        RESOLUTION ........................ 8 TO 16 BITS

   ANALOGIC CORP                    #AN7200              $1500           111
        RECALIBRATION ..................... 6 MONTHS
        TEMPERATURE RANGE ................. 0 TO 70 C
        CONVERSION ACCURACY ............... 0.01% FS (+1- 10 V)
        RESOLUTION ........................ 8 THRU 14 BINARY BITS
                                            2, 3, OR 4 BCD DIGITS
        DATA INPUTS ....................... DTL/TTL POSITIVE TRUE LOGIC ONE
                                            LOAD/LINE
        DATA .............................. UP TO 16 LINES (14 BINARY BITS
                                            OR 4 BCD DIGITS)
        ADDRESS ........................... 6 CHANNELS - 3 BITS
                                            24 CHANNELS - 5 BITS

424000 TAPE INPUT UNIT                                        SP001   11111
424000
424000 RECIEVES,STORES,TRANSMITS DATA OF OTHER EQUIPMENT
424000
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424000    TAPE CAPACITY..................1200FT(360M), 0.5IN.(1.3CM) WIDE
424000    TAPE SPEED.................... 25,18.75 AND 12.5 IN/S
424000         ........................(64,48 AND 32 CM/S)
424000    LONG TERM VARIATION...........+-1%
424000    DATA DENSITY...................1600 CPI (PHASE ENCODED)
424000              .....................200,556,800 CPI (NRZI)
424000
219700 STORAGE PERIPHERALS                                SP001    11111
219700
219700 THIS UNIT ACCEPTS ADDRESSED BINARY DATA FROM THE DIGITAL
219700 PROCESSOR AND TRANSLATES THIS DATA INTO EQUIVALENT ANALOG FORM.
219700
219700    MAXIMUM SIGNAL AND HOLD CHANNELS.32
219700    SIGNAL AND HOLD CHANNELS PER CARD..4
219700
376400 AUTOMATIC PHOTOGRAPHIC PROCESSOR                       SP001    11111
376400
376400 UNIT PROVIDES PROCESSED HOLOGRAMS AS PART OF THE ELECTRO-OPTICAL
376400 IMAGING SYSTEM
376400
376400    CYCLE TIME.....................BETWEEN 5 TO 20 SEC
376400    PLATE HOLDER SIZE..............4 IN(10CM) x 5 IN(13CM)
376400    EFFECTIVE APERTURE AT PHOTO
376400         PLATE.....................3.25 IN.(8.5CM) X 4.0 IN (10CM)
376400    DATA OUTPUT....................PROCESSED HOLOGRAMS
376400
    OPTICS TECHNOLOGY INC          #215                 $1995          111
        POWER LEVEL....................... 0.2 TO 1.0MW:   1.0 TO 2.0MW
        EXPOSURE TIME                      45 TO 180 SEC:  15 TO 60 SEC
        MOUNT............................. BENCH
        FILM PLATE SIZE................... 4 X 5IN
        HOLOGRAM TYPES.................... GABOR AND FRESNEL

    JODON ENGR ASSOC               #HS-2                $8700          111
        ACTIVE VIBRATION ISOLATION
        LASER............................. 20MW HE NE
        SYSTEM COMPONENTS................. REAL TIME PLATE HOLDER, SHUTTER
                                           BEAM STEERER, REFERENCE MIRRORS
                                           SPATIAL FILTERS, VARIABLE BEAM
                                           SPLITTER, ENCLOSURE

    HRB-SINGER INC.                  RP-31                             121
        FILM SIZE                          35MM
        FILM LENGTH                        250 FT.
        PROCESSING RATE                    0.5 TO 2 IN./SEC.

    JODON ENGINEERING ASSOC INC    #AP-100              $5850          111
        FLUID HANDLING SYSTEM
            MAXIMUM FLUID HEAD ........... 3 M
            HOSE FITTINGS ................ 9.5 M
            CYCLE TIME ................... 5 - 20 SEC
            TIMING ....................... 10 - 1000 SEC
            HOSE LENGTHS ................. UP TO 7.5 M
        PLATE HOLDER
            HOLDER SIZE .................. 10 x 13 CM
            PLATE THICKNESS SIZE ......... 1 x 6.4 MM
            EFFECTIVE APPERTURE AT
             PHOTO-PLATE ................. 8.5 MM x 10 CM
            OPTICAL CENTERLINE ........... 11.4 CM

480000 CCTV CAMERA                                        SP001    11131
480000
480000 HIGH RESOLUTION TELEVISION CAMERA FOR VIEWING, RECORDING OR
480000 TRANSMITTING PICTURES OF MATERIAL PROCESSING EXPERIMENTS
480000
480000    BANDWIDTH......................32MHZ
480000    VERTICAL SCAN LINES............1125 LINES
480000    HORIZONTAL RESOLUTION..........1100 LINES
480000    VERTICAL SWEEP RATE............25 OR 30 FRAMES PER SECOND
480000    SENSITIVITY....................100 IRE UNITS OUTPUT PRODUCED
480000                                   WITH 0.5 FOOTCANDLE ILLUMINATION
480000
    COHU ELECTRONICS INC.          #6150                $1943          111
        SCANNING ......................... 1225 LINES/FRAME
        INTERLACE ........................ 2:1
        FRAME RATE ....................... 25 OR 30 FRAMES/SEC.
        RESOLUTION(MAX) .................. 1100 LINES,32MHZ
        GEOMETRICAL DISTORTION ........... 2 PCT MAX
        SIGNAL TRANSMISSION DISTANCE ..... 500 FEET
        VERTICAL SWEEP RATES ............. 50 OR 60 HZ
        HORIZONTAL SWEEP RATES ........... UP TO 36,750 HZ
        SENSITIVITY ...................... 100 IRE UNITS OUTPUT PRODUCED
                                           WITH 0.5 FT-CANDLE HIGHLIGHT
                                           ON THE VIDICON FACEPLATE
603002 CCTV CAMERA CONTROL UNIT                               SP001    11131
603002
603002 THIS UNIT WILL PERFORM THE FOLLOWING CONTROL FUNCTIONS: LENS
603002 FOCUS, LENS F STOP, CONTRAST BRIGHTNESS AND MODE. THE UNIT WILL
603002 WORK IN TWO MODES:(1)CONTINUOUS OBSERVATION MODE,WHERE ILLUMINA-
603002 TION IS CONTINUOUS, OR (2) PULSED OBSERVATION MODE USED WHEN
603002 ILLUMINATION IS PROVIDED BY A DYE LASER OR A NAKED FLASH LAMP.
603002
603002    SCANNING.......................INTERLACED 2:1, THROUGH 1125
603002                                   LINES PER FRAME, 25 OR 30 FRAMES
603002                                   PER SECOND
603002    HORIZONTAL SCAN FREQUENCY CONTROL  36 TO 750 HZ
603002    VERTICAL SCAN FREQUENCY CONTROL  50 TO 60HZ
603002
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    COHU ELECTRONICS INC          #6576-000             $3140          111
        SCANNING ........................ INTERLACED 2 TO 1, THROUGH 1225
                                          LINES/FRAME, 25 OR 30 FR/SEC
        SCAN FAILURE PROTECTION ......... BEAM AUTOMATICALLY TURNED OFF
        CONTROLS HORIZONTAL SCAN FREQ .. TO 36,750 HZ
        CONTROLS VERTICAL SCAN FREQ .... 50 OR 60 HZ

376500 FRAME STORAGE UNIT                                  SP001   11111
376500
376500 THE FRAME STORAGE UNIT PROVIDES NONDESTRUCTIVE READOUT, ERASE,
376500 AND STORAGE ON ELECTRONIC COMMAND AND WORKS IN EITHER CONTINUOUS
376500 OR PULSED MODE. IT PROVIDES A REAL-TIME, NO PHOTOGRAPHIC
376500 PROCESSING, HIGH SPEED, AUTOMATIC LIGHT ADJUSTMENT CAMERA CAPABLE
376500 OF PROVIDING REAL-TIME MOVIES OR FROZEN STILLS
376500
       VIDEO STORAGE AND DISPLAY SYSTEM PRODUCED BY HUGHES AIRCRAFT.
       CONSISTS OF  MODEL 639 SCAN CONVERSION MEMORY, MODEL MSC-1 SCAN
       CONVERTER UNIT AND INTERFACES WITH TV MONITOR, HARD COPY RECORDER
       AND A VIDICON.

    HUGHES AIRCRAFT COMPANY       #639                  $5900          111
        RESOLUTION ...................... 1350 TV LINES/TARGET DIAMETER
                                          2100 TV LINES, LIMITING RES.
        CAPACITY ........................ TO 750,000 BITS
        WRITING SPEED ................... 30 MICROSEC/SCAN LINE OR
                                          25 NANOSEC/DOT
        ERASE ........................... 33 MS TO 5 PCT FOR A FULLY
                                          INSCRIBED SQUARE
        STORAGE ......................... 25 MINUTES CONTINUOUSLY READ:
                                          1-10 S STORAGE WITH CONTROLLED
                                          FADE; OPTIONAL LONG STORAGE IN
                                          BISTABLE OPERATION
        GRAY SCALE LEVEL ................ 10
        ZOOM ............................ MAGNIFICATION TO 6 DIAMETERS
                                          OVER ANY SELECTED PORTION OF
                                          THE STORED IMAGE

    HUGHES AIRCRAFT               #MSC-1                $2500          111
        INPUT COMMANDS................... RASTER ERASE, SELECTIVE ERASE,
                                          RASTER WRITE, GRAPHICS WRITE,
                                          PRIME
        VIDEO OUTPUT..................... NORMAL AND INVERTED
        OUTPUT BANDWIDTH................. 20HZ TO 10MHZ(FOR 525 LINE TV)
        SIGNAL-TO-NOISE RATIO............ 35DB, TYPICAL
        AMPLITUDE........................ OV OFF, +4V ON

484000 TV MONITOR                                          SP001   11111
484000
484000 THE MONITOR WILL DISPLAY CCTV IMAGES AS PART OF THE ELECTO-
484000 OPTICAL IMAGING SYSTEM.
484000
484000    SCANNING FREQUENCIES...........HORIZONTAL: 15-40 KHZ
484000                    ...............VERTICAL: 15-60 FIELDS/SECOND
484000    VERTICAL SCAN LINES............1125 LINES
484000    LINEARITY.................... ...1% PICTURE HEIGHT
484000
    COHU INC. ELECTRONICS DIV     #9600                 $5260
        PICTURE SIZE .................... 7-3/16W X 5-3/8H INCHES
        HORIZONTAL SCAN ................. 945 LINES, 50 OR 60 FIELDS/SEC
                        ................. 873 LINES, 60 FIELDS/SEC
        VIDEO BANDWIDTH ................. 20 MHZ +/- 2 DB
        POWER ........................... 25-28.5 VDC, 150 WATTS
359500 OSCILLOSCOPE                                        SP001   11111
359500
359500 DISPLAY OF THE PRESENCE AND/OR NATURE AND FORM OF OSCILLATIONS
359500 OR IRREGULARITIES OF AN ELECTRIC CURRENT. STORAGE CAPABILITY OF
359500 A CRT DISPLAY IS DESIRED FOR PROLONGED OBSERVATIONS.
359500
359500    BANDWIDTH......................DC TO 10MHZ
359500    SENSITIVITY....................INTERNAL: 0.2CM DEFLECTION TO
359500                                   1 MHZ
359500         ..........................EXTERNAL: 250MV P-P TO 15V P-P
359500    VIDEO STORAGE TIME.............1 HOUR
359500
    TEKTRONIX INC                 #7904/7A19 PLUG-IN    $6050          111
                                  /7B70 PLUG-IN
        BANDWIDTH ....................... DC TO 500 MHZ
        CHANNELS ........................ 2
        DEFLECTION FACTOR ............... 10 MV/DIV TO 1 V/DIV
        TIMEBASE ........................ 2 NS/DIV TO 5 S/DIV

    HEWLETT/PACKARD               #AN/USM-281A          $3100          111
        MEETS MIL-SPEC REQUIREMENTS
        BANDWIDTH........................ DC TO 5MHZ
        SENSITIVITY...................... 0.1V/DIV TO 1.0V/DIV
        CHANNELS......................... 2

    HEWLETT PACKARD               #1800/1811A           $2750          111
        BANDWIDTH ....................... 4 OR 18 GHZ
        DEFLECTION FACTOR ............... 2 MV
        CHANNELS ........................ 2
        PHOTOGRAPHIC CAPABILITY ......... YES

    TEKTRONIX INC                 #P465                 $1800          111
        BANDWIDTH ....................... DC TO 100 MHZ
        CHANNELS ........................ 2
        DEFLECTION FACTOR ............... 5 MV/DIV TO 5 V/DIV
        TIME BASE ....................... 0.01 MICROSEC/DIV TO 0.5 S/DIV
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TEKTRONIX                           #485                $4200          111
     RANGE,CALIBRATED................  5MV/DIV TO 5V/DIV IN 10 STEPS
          UNCALIBRATED............... CONT VAR TO 12.5V/DIV
     RESPONCE TIME....................LESS THAN 1 NS
     CHANNELS........................ 1,ALTERNATE, CHOPPED,ADDED,X-Y
          ........................... CHANNEL 2 (+UP OR INVERTED)
     WEIGHT.......................... 9.5 KG
     DIMENSIONS...................... 16.7 X 52.4 X 30.5 CM
     POWER........................... 115/230V 48-440HZ  60W
     BANDWIDTH.......................350 MHZ

TEKTRONIX INC                       #R5618/3A6 PLUG-IN/  $1840         111
                                     3B4 PLUG-IN
     BANDWIDTH ...................... DC TO 10 MHZ
     CHANNELS ....................... 2
     DEFLECTION FACTOR .............. 10 MV/DIV TO 10 V/DIV
     TIMEBASE ....................... 50 NS/DIV TO 5 S/DIV
     RISETIME ....................... 35 NS

HEWLETT-PACKARD                     #132A               $1500          111
     BANDWIDTH ...................... DC TO 500KHZ
     SENSITIVIY .....................  100 MICROVOLTS/CM
     INDEPENDENT BEAMS ..............  2
     WEIGHT .......... .............. 43 POINDS

048800 FLUID COOLING/REFRIGERATION UNIT                      SP001   11114
048800
048800 THIS UNIT MAINTAINS THE ELECTROPHORETIC SEPARATION SYSTEM, THE
048800 BUFFER SUPPLY AND SAMPLE AT A CONSTANT LOW TEMPERATURE. IT
048800 CONTROLS THE TEMPERATURE OF THE GAS ELIMINATION SYSTEM. ALSO
048800 IT COOLS (OR HEATS) THE BUFFER/SAMPLE SOLUTION(S) AND THE BUFFER
048800 USED IN THE ELECTRODE COMPARTMENTS OF THE COLUMNS.
048800
048800    CONTROLLED TEMPERATURE RANGE...-13F TO 113F (25 TO 45C)
048800    TEMPERATURE ACCURACY...........+/-1.0F (+/-0.56C)
048800    SYSTEM RECOVERY TIME...........2 MINUTES
048800    MAXIMUM HEAT REJECTION.........2KW THERMAL
048800
355500 LASER OPTICAL SCATTERING MONITOR                      SP001   21111
355500
355500 THE LASER OPTICAL SCATTERING MONITOR WILL PROVIDE A REAL TIME
355500 MEASURE OF LIGHT SCATTERING IN A SPECIMEN AT ANY DESIRED MEASUR-
355500 ING ANGLE. THIS DATA WILL PROVIDE INFORMATION ON THE SIZE, SHAPE,
355500 ORIENTATION, INDEX OF REFRACTION, CONCENTRATION AND LOCATION OF
355500 OPTICAL SCATTERING CENTERS.
355500
355500    LASER TYPE.....................LOW-POWER UV GAS DISCHARGE
355500    FILTER BANDWIDTH...............4E-5 IN.(0.1NM) AT HALF POWER
355500    SCATTERED LIGHT INTENSITY
355500         ACCURACY..................0.1%
355500    ANGULAR POSITION ACCURACY.....1 MIN (0.3MRAD)
355500
459619 UV-VIS  SPECTROMETER                                  SP001   21111
459619
459619 MEASUREMENT OF SAMPLE CONSTITUENTS  BASED ON THE UV AND VISIBLE
459619 SPECTRUM.
459619
459619    RANGE ......................... 150 TO 1000 NM
459619    WAVELENGTH/WAVENUMBER ACCURACY..+/- 0.1 NM FS
459619    RESOLUTION .................... 0.05 NM
459619    RESPONSE TIME ................. 2 SECONDS
459619    SCANNING SPEED ................ 0.02 TO 2.0 NM/SEC
459619
   VARIAN INSTRUMENTS               #CLARY 17           $28300         111
        WAVELENGTH RANGE ............ 186-2650 NM

   VARIAN INSTRUMENTS               #CLARY 118          $16645         111
        WAVELENGTH RANGE ............ 185-800 NM

   COLEMAN                          #46                 $4800          111
        FREQUENCY RANGE ............. 195 TO 800 MILLIMICRONS
        RESOLUTION................... 0.2 MILLIMICRONS
        READOUT ..................... DIGITAL
        WAVELENGTH ACCURACY ......... +/-0.5NM

   COLEMAN-HITACHI                  #EPS-3T             $11500         111
        FREQUENCY RANGE ............. 170 TO 2600 MILLIMICRONS
        WAVELENGTH ACCURACY.......... 0.4 MILLIMICRONS IN UV
                                      1.5 MILLIMICRONS AT 300 TO 600
                                         MILLIMICRONS
                                      2.0 MILLIMICRONS AT 600 TO 700
                                         MILLIMICRONS
                                      8.0 MILLIMICRONS IN NIR

   PERKIN ELMER INSTRUMENT DIV      #323                $15200
        WAVELENGTH RANGE ............ 185 TO 2500 NANOMETERS
        MODES ....................... X-Y RECORDER
                                      AUTOMATIC REPETATIVE SCAN

   G K TURNER                       #350                $1609          111
        WAVELENGTH RANGE ............ 210 TO 1000 NM
        ACCESSORIES ................. 330-030 IR ACCESSORIES
                                      330-040 UV ACCESSORIES
        OPTICS ...................... REFLECTION TYPE
        WAVELENGTH ACCURACY ......... +/- 2 NM
        WAVELENGTH READOUT .......... DIGITAL 1% NM
        PHOTOMETRIC METER ACCURACY .. +/- 0.5%
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BECKMAN INSTRUMENTS          #133500 ACTA CV      $13630          111
     RANGE ............................ 160-1000 NM
     OPERATING RANGE .................. 190-800 NM
     ACCURACY ......................... +/-.1 NM
     RESOLUTION ....................... .05 NM
     RESPONSE TIME .................... .5 OR 2 SECONDS
     SCANNING SPEED ................... .025 TO 4 NM/SEC (7 SPEEDS)
     POWER ............................ 120V 50/60 HZ 3A
     DIMENSIONS ....................... 61X21X24 INCHES

227800 DYE LASER/FLASH LAMP                                   SP001   31111
227800
227800 THIS UNIT WILL BE USED FOR FREE RADICAL GENERATION, SURFACE
227800 DAMAGE THRESHOLD DETERMINATION, AND HOLOGRAPHIC MICROSCOPY
227800
227800  ACCURACY:
227800   WAVELENGTH.......................C.01%
227800   VOLTAGE OF CAPACITOR BANK.......C.1%
227800   LASER AND FLASH LAMP ENERGY
227800      OUTPUT........................1.0%
227800   SYNC. ACCURACY..................100NS
227800   COHERENCE........................20%
227800  RANGE OF OPERATION:
227800   ENERGY INPUT....................500-5000J/PULSE (.14-1.4WH/PULSE
227800                                   ) AT LOW REPS, LARGE LAMP
227800                 ..................50-500J/PULSE (.014-.14WH/PULSE)
227800                                   AT HIGH REPS, SMALL LAMP
227800   ENERGY OUTPUT...................1-30J/PULSE (3E-4 - 8E-3WH/PULSE
227800                                   ) AT LOW REPS, DYE FUND. FREQ.,
227800                                   250MJ TO 7J/PULSE (7E-5 - 2E-3
227800                                   WH/PULSE) FREQUENCY DOUBLED.
227800                 ..................100MJ TO 3J/PULSE (3E-5 TO 8E-4
227800                                   WH/PULSE)AT HIGH REPS AT DYE
227800                                   FUNDAMENTAL, 25 - 750MJ(7E-6 -
227800                                   2E-4 WH) FREQUENCY DOUBLED
227800   REPETITION RATE.................LARGE LAMP - SINGLE TO 10/MIN
227800                 ..................SMALL LAMP - SINGLE TO 20HZ
227800   FREQUENCY RANGE.................FUNDAMENTAL 430 - 750NM(1.7E-5
227800                                   TO 3E-5 IN.) FREQUENCY DOUBLED
227800                                   215 - 375NM (0.9E-5 TO 1.5E-5
227800                                   IN.)
227800    FLASH DURATION.................500 - 100NS
227800    HOLOCAMERA.....................35MM (1.4 IN.)
227800           ........................SINGLE FRAME TO 20FRAMES/SEC.
227800
227800 FLASH LAMP                                             SP001   31111
227800
227800 THE FLASH LAMP HAS TWO FUNCTIONAL REQUIREMENTS: (A)TO PRODUCE
227800 FREE RADICALS, AND (B)AS A PUMP SOURCE FOR EXCITING THE DYE
227800 LASER
227800
227800    TYPE...........................MERCURY-XENON
227800    OPERATING TEMPERATURE..........68 TO 77F ( 20 TO 25C)
227800    WAVELENGTH.....................1.2E-5 TO 2.4E-5 IN. (300-600NM)
227800    ENERGY INPUT(MAX)..............1.5WH (5KJ)
227800                (MIN)..............0.3WH (1KJ)
227800
268500 RETROCONSTRUCTION HIGH RESOLUTION HOLOMICROSCOPE       SP001   31235
268500
130000 DIALYSIS UNIT                                          SP001   11113
130000
   OXFORD                     #10                    $59             111
       GLASS CONTAINER WITH MOTORIZED AGITATOR
       SPECIMEN CAPACITY................ 8


415500 METERING PUMPS                                         SP001   11111
415500
415500 BUFFER AND SPECIMEN METERING PUMPS FOR CONTINUOUS FLOW
415500 ELECTROPHORETIC COLUMN
415500
       FLOW RATE.........................0.007ML/MIN TO 30ML/MIN
       PRESSURE HEAD.....................5.8 TO 14 PSI(4E04 - 10E04N/M2)
415500    REPRODUCIBILITY.................+-0.5%
415500
   CHROMATRONIX INC                                                  111
       FLOW RATE ....................... 2.4 TO 600 ML/HOUR
       REPEATABILITY ................... 0.02%
       ABSOLUTE ACCURACY ............... 0.2%

   VWR SCIENTIFIC             #220 (54845-202)       $995            111
       FLOW RATE ....................... 7 MICRO-LITER/MIN TO 30 MILLI-
                                         LITER/MIN
       REPRODUCIBILITY ................. +/- 0.5 PCT
       BACK PRESSURE RANGE ............. 4E+4 TO 10E+4 N/SQ M

   SAGE                       #355                   $475            111
       DISCRETE RATES................... INFINITE
       MINIMUM VOLUME/MIN............... 0.0004ML
       MAXIMUM VOLUME/MIN............... 140ML

   SAGE                       #375                   $495            111
       DISCRETE RATES................... INFINITE
       MINIMUM VOLUME/MIN............... 1ML/MIN
       MAXIMUM VOLUME/MIN...............  1200ML/MIN

149378 CONTINUOUS FLOW ELECTROPHORETIC COLUMN WITH PUMP       SP001   11114
149378
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ORIGINAL PAGE IS
OF POOR QUALITY

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149378 THIS UNIT SEPARATES BIOLOGICAL SAMPLES BY ELECTROPHORESIS.
149378 RELATIVELY LARGE SAMPLES, APPROXIMATELY 10 CC, WILL BE PROCESSED.
149378 SAMPLE AND BUFFER FLOW WILL BE CONSTANT AND SAMPLE FRACTION
149378 COLLECTION CONTINUOUS.
149378
149378    TOTAL BUFFER AND SAMPLE VOLUME..   60CU.IN. (1000CC)
149378    OPERATING TEMPERATURE.........     14 TO 41 F(-10 TC 5C)
149378    OPERATING TEMPERATURE REGULATION       +/-2F (+/-1C)
149378    SEPARATION PROFILE ACCURACY...         +/-.004IN(+/-.1MM)
149378    POSITION MONITOR ACCURACY.....         +/-.004IN(+/-.1MM)
149378    FRACTION OUTLET PORT LOCATION ACCURACY  +/-.004IN(+/-.1MM)
149378    INPUT VOLTAGE.................              5000V
149378
    BUCHLER                          #VFR 30136-C56        $31          111
         INTERNAL DIAMETER................ 13MM
         LENGTH........................... 140MM

149390 STATIONARY ELECTROPHORETIC COLUMNS                       SP001   11114
149390
149390 THE STATIONARY ELECTROPHORETIC COLUMNS HAVE TWO ANTICIPATED
149390 USAGES: (A)TO ESTABLISH PROCESSING AND OPERATING PARAMETERS FOR
149390 THE CONTINUOUS ELECTROPHRETIC COLUMNS, AND (B) FOR SMALL BATCH
149390 PROCESSING (APPROXIMATELY 0.1CC(.006 IN**3)) OF VARIOUS
149390 BIOLOGICAL COMPONENTS
149390
149390    TOTAL BUFFER AND SAMPLE VOLUME ....1.5CU.IN. (25CC)
149390    SEPARATION VELOCITY ACCURACY..      +/-0.04IN (+/-1MM)
149390    POSITION MONITOR ACCURACY.....      +/-0.04IN (+/-1MM)
149390    OPERATING TEMPERATURE RANGE...      14 TO 41F (-10 TC 5C)
149390    TEMPERATURE TOLERANCE.........      +/-2F (+/-1C)
149390
004400 GAS ELIMINATION SYSTEM                                   SF001   11114
004400
004400 REMOVES GASSES PRODUCED BY ELECTROLYSIS IN THE ELECTRODE
004400 COMPARTMENTS OF THE ELECTROPHORETIC COLUMNS
004400
004400    OUTLET OXYGEN CONCENTRATION...     3% (BY VOLUME)
004400    OUTLET HYDROGEN CONCENTRATION.     2% (BY VOLUME)
004400    MAX FLOW RATE.................       TBD
004400    FLOW RATE CONSTANCY...........      +-1%
004400    OPERATING TEMPERATURE.........  68 - 77 F (20 - 25 C)
004400
410000 BUFFER AND ELECTROLYTE SUPPLY TANKS                      SP001   11113
410000
374000 PH MONITOR                                               SP001   21111
374000
374000 MEASURE ACIDITY AND ALKALINITY OF SOLUTIONS. USED IN GP LAB ALSO
374000
374000    PH RANGE...................... 4.2 TO 12
374000    SELECTABLE RANGES............. ANY 2
374000                  ................ ANY 5
374000                  ................ ANY 10
374000    READING STABILITY............. 0.02 PH
374000    LIQUID TEMPERATURE RANGE...... 32 TO 212 F (0 TO 100 C)
374000
    BECKMAN INSTRUMENTS          #PHASAR 1            $570
         PH RANGE......................... 0.00 +0 14.00
         REPEATABILITY.................... +/- 1 MV, +/- 0.01 PH
         AUTO TEMP COMPENSATION........... 0 +0 100 C
         DIMENSIONS ...................... 5-3/4HX12-3/4WX8-5/8D(INCH)
         WEIGHT .......................... 5 LB
    BECKMAN INSTRUMENTS INC      #940                 $1000          111
         RANGE ........................... 0 - 12 PH UNITS
         SPANS ........................... 2, 5, OR 10 PH UNITS
         STABILITY ....................... +/- 0.02 PH UNITS
         AMBIENT TEMP RANGE .............. -7 TO 50 DEG C
         LIQUID TEMP RANGE ............... 0 TO 100 DEG C
         AMBIENT TEMP COEFFICIENT ........ +/- 0.002 PH UNITS/DEG C

    PERKIN ELMER CORP               COLEMAN 28C        $265
                                    (METRION IV)
         RESOLUTION                  0-14PH +/- 0.05PH
         ACCURACY                    2% FULL SCALE

    BECKMAN INSTRUMENTS          #76007               $550           111
         RANGE ........................... 0 TO 14PH
         ACCURACY ........................ +/-.05PH(+/-.01PH(EXPANDED)
         REPEATABILITY ................... +/-.02PH(1PH.01PH(EXPANDED)
         TEMP COMPENSATION ............... 0 TO 100 C
         RECORDER OUTPUT ................. UP TO 200 MV
         POWER ........................... 115/230V 50/60 HZ 15W
         DIMENSIONS ...................... 11X11X9 INCHES
         WEIGHT .......................... 9 LBS

    BECKMAN INSTRUMENTS          #100900              $420           111
         RANGE ........................... 0 TO 14PH
         ACCURACY ........................ +/-.05PH FULL SCALE
         REPEATABILITY ................... +/-.02PH
         TEMP COMPENSATION ............... 0 TO 100 C
         POWER ........... ............... 115V 50/60 HZ 2W
         DIMENSIONS ...................... 11.38X9X5.38 INCHES
         WEIGHT .......................... 6.25 LBS
         RECORDER OUTPUT ................. 10 TO 100 MV

177000 FRACTION COLLECTION SYSTEM                               SP001   11235
177000
177000 THIS APPARATUS WILL HAVE TWO FUNCTIONS: (1) TO COLLECT THE
177000 DESIRED FRACTIONS AFTER SEPARATION, AND (2) TO REMOVE THE EXCESS
177000 BUFFER SOLUTION AND REMAINING UNWANTED SAMPLES
177000
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177000    PUMP TYPE.....................POSITIVE DISPLACEMENT
177000                          1.8 CU.IN/MIN (30 CC/MIN)
177000    PUMPING RATE ACCURACY.......+-C.1%
177000    ALLOWABLE PUMP PULSATION......C.01PSI (+/-7C N/M2)
177000    TEMPERATURE REGULATION.........+/-1.0F (+/-0.5C)
177000
173000 FLOW METER                                          SP001   11111
173000
173000 GAS FLOW METERING AND MONITORING DEVICE.
173000
173000    GAS TYPE ...................... OXYGEN, NITROGEN, HELIUM
173000    GAS FLOW RATE ................. 0.4 TO 0.3 LB/HR
173000                                    0.3 TO 3.0 LB/HR
173000
   TECHNOLOGY/VERSATRONICS INC    #MFG-3               $970         111
       OUTPUT(SINGLE ENDED) ........... 0-5VDC LINEAR IN MASS FLOW
       OUTPUT IMPEDANCE ............... <10 OHM
       ACCURACY(ABSOLUTE) ............. +OR-2% OF READING 20 TO 100% FS
                                        +OR-20MV FROM 0 TO 20% FS
       LINEARITY ...................... +OR-0.4% FULL SCALE (FS)
       REPEATABILITY .................. +OR-0.1% FO READING
       CALIBRATION PRESSURE ........... 1 ATMOSPHERE
       STD CALIBRATION TEMP RANGE ..... 55 TO 155F
       MEDIUM ......................... AIR
       TIME CONSTANT .................. LESS THAN 0.07 SEC
       PRESSURE DROP .................. LESS THAN 1 IN H2O
       READOUT ........................ 1% TAUT BAND MIRROR SCALE
                                        0-100% FLOW RATE
       AVAILABLE RANGE ................ 0.12 TO 0.6 CU FT PER MIN
       SIGNAL CONDITIONER ............. 0 TO 40F
       TRANSDUCER ..................... -45 TO 150F

235700 LYOPHILIZATION UNIT                                 SP001   11111
235700
   SCINTIFIC PRODUCTS DIV         #07C27-5             $1390        111
       CONFIGURATION .................. BENCH EQUIP
       TYPE ........................... FRONT LOADING, SINGLE SHELF
       TEMPERATURE RANGE .............. -40 TO 122 C (-40 TO 250 F)

   VIRTIS                         #UNITRAP             $1300        111
       TEMPERATURE(MIN).................-65F(-55C)
       DRUM SIZE....................... 8IN(21CM)DIA.X10IN(25.4CM) HIGH
       CONFIGURATION................... FLOOR MOUNT, PORTABLE
       VACUUM PUMP NOT INCLUDED

   SARGENT WELCH SCIENTIFIC CO.   #S-28881-80          $3510        111
       LOW TEMPERATURE ................ -65F
       CAPACITY ....................... 12 LITERS
       VACUUM ......................... 5 MICRONS
       PUMP CAPACITY .................. 140 LITERS/MIN.

217500 RECIRCULATING FLUID INCUBATOR                       SP001   11112
217500
435000 DISSOLVED OXYGEN ANALYZER                           SP001   11111
435000
435000 THE UNIT WILL DETERMINE THE AMOUNT OF DISOLVED OXYGEN PRESENT IN
435000 THE ELECTROLYTE AFTER IT HAS BEEN PROCESSED THROUGH THE GAS
435000 ELIMINATION SYSTEM. IT WILL MONITOR OXYGEN DURING A REACTION
435000 EXPERIMENT  IT WILL ALSO FUNCTION AS A GASEOUS OXYGEN MONITOR
435000
435000    CONCENTRATION RANGE........... 0 TO TOTAL OXYGEN SATURATION
435000    ACCURACY...................... +/- 1%
435000    RESPONCE TIME................. 90% ACTUAL IN 10SECONDS
435000    SAMPLE TEMPERATURE RANGE...... 32 TO 110F (0 TO 43C)
435000
   BECKMAN INSTRUMENTS            #100800 FIELDLAB     $475         111
       RANGES:DISSOLVED O2 ............ 0-1;0-10;0-25PPM
       RANGES:GASEOUS O2 .............. 0-2.5%;0-10%;0-25%;0-100%
       ACCURACY ....................... +/- 1.0% FS
       REPEATABILITY .................. .5% FS
       RESPONSE TIME .................. 90% IN 10SEC GASEOUS O2
                    .................... 90% IN 30SEC DISSOLVED O2
       TEMPERATURE RANGE .............. 0 TO 45 C
       POWER .......................... 115V 50/60 HZ
       DIMENSIONS ..................... 11.375X9X5.375INCHES
                ....................... 28.8X22.9X13.6 CM
       WEIGHT ......................... 7.5 LBS (3.3KG)

   BECKMAN INSTRUMENTS INC        #778                 $700         111
       CONCENTRATION RANGE ............ ZERO TO TOTAL O2 SATURATION
       UNITS READ ..................... PPM OR MG OF O2 PER LITER
       TEMPERATURE RANGE .............. 0 - 40 DEG C
       ACCURACY ....................... +/- 1 PCT AT MEASURING TEMP
       RESPONSE TIME .................. 90 PCT OF ACTUAL CONCENTRATION
                                         WITHIN 10 S

   IBC                            #G1998-25            $622.50      111
       CONCENTRATION RANGE............. 0 TO 100%
       ACCURACY........................ +/-2%
       TEMPERATURE RANGE............... 32 TO 122F (0 - 50C)
       RESPONCE TIME................... 95% IN 15 SEC

410000 SPECIMEN/SAMPLE SUPPLY TANKS                        SP001   11113
410000
407000 HIGH VOLTAGE POWER CONDITIONER                      SP001   11112
407000
407000 PROVIDES DC VOLTAGE TO EITHER THE STATIONARY OR CONTINUOUS FLOW
407000 ELECTROPHORETIC COLUMNS. REGULATION MUST REMAIN CONSTANT OVER
407000 A RELATIVELY LARGE CURRENT DEMAND.
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407000
       OUTPUT VOLTAGE REGULATION.........+/- 0.1%
407000    VOLTAGE RANGE..................25 TO 2500 VDC
407000    READOUTS.......................VOLTAGE LEVEL
407000    POWER OUTPUT TO COLUMNS........20W SUSTAINED
407000                                   200W PEAK
407000
     JOHN FLUKE MFG CO INC        #415B                 $575          111
       OUTPUT VOLTAGE .................. 0 TO 3100 VDC
       CURRENT ......................... 30 MA
       REGULATION ...................... 0.0005%
       STABILITY ....................... +/- 0.01% PER DAY

     TRANSIDYNE GENERAL CORP      #2815                 $1475
       VOLTAGE OUTPUT .................. 0 - 5 KV DC
       CURRENT OUTPUT .................. 200 MA
       RIPPLE .......................... LESS THAN 1 MV RMS
       ACCURACY ........................ +/- 0.1 PCT

     SORENSEN                     #DCR6000-.25A         $1485         111
       OUTPUT VOLTAGE................... 60 TO 6000VOLTS
       OUTPUT CURRENT (MAX)............. 0.287AMPS
       REGULATION....................... +/-0.075% OR +/-1.2V
       CONFIGURATION.................... RACK MOUNT
       SIZE............................. 19X121/4X18IN
       WIEGHT........................... 170 LB(80KG)

229500 DARK FIELD ILLUMINATOR                                 SP001   21111
229500
048700 REFRIGERATOR                                           SP001   11111
048700
048700 THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES
048700
048700    TEMPERATURE......................32 - 68F (0 - 20C )
048700    LENGTH...........................2FT (60CM)
048700    WIDTH............................1.8FT (54CM)
048700    HEIGHT...........................2.8FT (84CM)
048700
     MATHESON SCIENTIFIC          #32C35-25             $685          112
       CAPACITY ........................ 12.8 CU FT
       TEMPERATURE ..................... -15 TO 27.8 C.
       SHIELDED AREA ................... NONE
       DIMENSIONS ...................... 32X32X60 INCHES
       EXPLOSION PROOF.................. YES
       COMPRESSOR ...................... 0.17HP
       POWER ........................... 115V 50-60 HZ 3.5A
       WEIGHT .......................... 275 LBS

178200 FREEZER                                                SP001   11111
178200
178200 THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES
178200
178200    CONTROLLED TEMPERATURE RANGE..-13F TO 113F (-25C TO 45C)
178200    LENGTH...........................1FT (30CM)
178200    WIDTH............................1.8FT (54CM)
178200    HEIGHT...........................2.8FT (84CM)
178200
     REVCO                        #ULT-185A             $1060         111
       TEMP RANGE ...................... -7 TO -85 C
       CAPACITY......................... 1.5 CU FT
       DIMENSIONS....................... 34X24X37 INCHES
       WEIGHT........................... 270 LBS (SHIPPING)
       POWER ........................... 115V 60 HZ 7A
       CAPACITIES AVAILALBE............. 1.5 TO 17 CU FT (VAR.PRICES)

108600 DEWAR                                                  SP001   11111
108600
108600 THIS UNIT WILL BE USED FOR COLD STORAGE OF BIOLOGICAL SAMPLES
108600
108600    TEMPERATURE......................-112F  (-80C)
108600    LENGTH...........................1FT (30CM)
108600    WIDTH ...........................1.8FT (54CM)
108600    HEIGHT...........................2.8FT (84CM)
108600
     CRYOGENIC ASSOCIATES         #1R-90                $1000
       CAPACITY..........................0.6L LIQ. N2
       HOLDING TIME......................24 HOURS
       DIMENSIONS........................4.25IN DIAM, 8.5IN LONG
       WEIGHT............................1.5LB(EMPTY),2.5LB(FULL)

410000 WASTE LIQUID TANK                                      SP001   11113
410000
004400 MOLECULAR SIEVE                                        SP001   41133
004400
004400 THE MOLECULAR SIEVE IS USED TO CLEAN GASSES GENERATED IN FURNACES
004400 AND EXHAUSTED TO SPACE. THIS UNIT IS ALSO USED IN THE FURNACE,
004400 GENERAL PURPOSE AND LEVITATION SUBELEMENTS
004400
     UNION CARBIDE CORPORATION    #TYPE 13X (POWDER) $1.90/LB         114
                                            (PELLETS) $1.59/LB        114
       TYPES AVAILABLE ................. POWDER
                                         1/16 AND 1/8 INCH PELLETS
       NOMINAL PORE DIAMETER ........... 10 ANGSTROM
       POURED DENSITY(AVERAGE) ......... 38 LB/CU FT (PELLETS)
       SETTLED BULK DENSITY ............ 42 LB/CU FT (PELLETS)
       HYDRATED WET DENSITY ............ 1.95 G/CU CM (POWDER)
       ACTIVATED DRY DENSITY ........... 1.53 G/CU CM (POWDER)
       CRUSH STRENGTH .................. 9 LB (1/16 IN PELLETS)
                                         24 LB (1/8 IN PELLETS)
       CRYSTAL FORM .................... OCTOHEDRAL (POWDER)
       HEAT OF ABSORPTION .............. 1800 BTU/LB H2O
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410000 COOLANT SUPPLY TANK                                    SP001   11113
410000
625010 ISOELECTRIC FOCUSING UNIT                              SP001   11114
625010
186000 HOT WALL TUBE FURNACE                                  SP002   31111
186000
186000 THIS  UNIT  IS A GENERAL PURPOSE,HOT WALL HEATING DEVICE
186000 PROVIDING ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH
186000 RESPECT TO A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.
186000
186000     VACUUM LEVEL....................2E-8 PSI (195E-6N/M2)
186000     OPERATING TEMPERATURE..........2200F (1200C)
186000     MAX EXTERNAL SURFACE TEMP......110F (45C)
186000     HOT ZONE DIMENSIONS............2.5 IN (6CM) DIA. X 6IN(15CM)LNG
186000     MAXIMUM DEVIATION FROM FLAT
186000         PROFILE.....................+/-4F (+/-2C)
186000
    ASTRC INDUSTRIES INC           #A222                $1000          113
        HOT ZONE DIMENSIONS ............. 5 CM DIA. BY 28 CM LONG
        MAX SUSTAINED TEMP .............. 1200 DEG C

    LINDBERG HEVI-DUTY             #F8417               $355           111
        MAX OPERATING TEMPERATURE ....... 2200F (1200C)
        CHAMBER SIZE .................... 1IN I.D.X 12IN LONG
        POWER ........................... 570W

    LECO                           #521-300             $1370          111
        INDUCTION FURNACE
        TEMPERATURE(MAX)..................>3000F (>1700C)
        POWER............................ 1.5KW


186000 HOT WALL FURNACE                                       SP002   21111
186000
186000 THIS UNIT IS A GENERAL PURPOSE, HOT WALL HEATING DEVICE PROVIDING
186000 ACCURATE CONTROL OVER THE HOT ZONE TEMPERATURE WITH RESPECT TO
186000 A FLAT PROFILE OR TO A SPECIFIED GRADIENT PROFILE.
186000
186000     VACUUM LEVEL....................2E-8 PSI (1.5E-4N/M2)
186000     OPERATING TEMPERATURE..........3300F (1800C)
186000     EXTERNAL SURFACE TEMPERATURE..110F (45C)
186000     HOT ZONE DIMENSIONS(MIN).......1IN. (2.5CM)DIA.X5IN.(13CM)LONG
186000     MAXIMUM DEVIATION FROM FLAT
186000          PROFILE....................+/-7F (+/-4C)
186000     VIEWPORTS.......................2
186000
    ASTRC INDUSTRIES INC           #1100V - 1060-M1     $3100          113
        HOT ZONE DIMENSIONS ............. 2.5 CM DIA. BY 15 CM LONG
        MAX SUSTAINED TEMP .............. 1800 DEG C
        TIME TO TEMPERATURE ............. 10 MINUTES MAX
        HEATING ELEMENT ................. MOLYBDENUM MESH WITH MOLYBDENUM
                                          SHEET RADIATION SHIELDS
        OPERATION ENVIRONMENTS .......... VACUUM, INERT GAS, AND REDUCING
                                          ATMOSPHERES
        OBSERVATION ..................... SHUTTERED RADIAL VIEWPORT
        ACCESS .......................... TOP AND/OR BOTTOM
        COOLING ......................... WATER COOLED

    LECO                           #VFR 30646-008       $2065          111
        TEMPERATURE(MAX)................. 3000F (1700C)
        CHAMBER DIMENSIONS............... 4X4X5 1/4IN (10X17.8X21CM)
        POWER............................ 3KW

    LINDBERG                       #51000               $1350          111
        TEMPERATURE(MAX)................. 2700F (1500C)
        CHAMBER DIMENSIONS............... 6X5X12IN (15.4X12.7X30.4CM)
        POWER............................ 5KW

186000 CHEST-GENERAL PURPOSE ENCLOSURE                        SP002   31113
186000
186000 THE PRIMARY FUNCTION OF THE ENCLOSURE IS TO ISOLATE THE HEATED
186000 SPECIMEN FROM THE LABORATORY ENVIRONMENT, BOTH THERMALLY AND
186000 ATMOSPHERICALLY, AND TO PROVIDE A MEANS TO STRUCTURALLY ATTACH
186000 THE VARIOUS HEATING ELEMENTS AND ACCESSORY ITEMS
186000
186000     VACUUM LEVEL....................2E-10PSI (1.5E-6N/M2)
186000     MAXIMUM INTERNAL TEMP..........5400F (3000C)
186000     MAX EXTERNAL SURFACE TEMP......110F (45C)
186000     HOT ZONE DIMENSIONS(MIN).......1IN.(2.5CM)DIA.X4IN(10CM) LONG
186000     FULL LENGTH FRONT OPENING DOOR
186000     VIEW PORTS......................FRONT,REAR,2 SIDES,BOTTOM,TOP
186000     FLANGE OPENINGS.................TOP,BOTTOM,2 EACH SIDE,2 REAR
186000
    SATEC SYSTEMS INC              #VC-208                             113
        VACUUM CAPABILITY ............... 1.3E-6 N/SQ M
        ENCLOSURE CONSTRUCTION .......... DOUBLE-WALL WITH WATER COOLING
                                          OF ALL SURFACES
        DOOR ............................ FULL LENGTH FRONT OPENING
        VACUUM PUMPING CONNECTION ....... 15 CM INSIDE DIA ON LOWER CHEST
        INSTRUMENTATION LEAD-IN ......... 10 CM INSIDE DIA ON UPPER CHEST
        VACUUM SEALING .................. METAL-TO-METAL SEALS

    ASTRC (FURNACE)                #1000A               $4875          113
        TEMPERATURE...................... 5400F (3000C)
        PRESSURE CAPABILITY.............. VACUUM TO 15PSIG
        POWER SUPPLY..................... 12KVA
        HOT ZONE DIMENSIONS.............. 2.44IN DIA X 6 IN.
        COOLING.......................... WATER
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    MATERIALS RESEARCH             #PRZ-3P            $30,000          111
        OPERATING TEMPERATURE............ UP TO 3000C
        COMPATIBLE WITH RF INDUCTION OR ELECTRON BEAM
        POWER............................ 3KVA
        VACUUM........................... 10E-6 TORR
        PROCESS CHAMBER.................. 12X12 HINGED PYREX BELL JAR

185450 DIRECTIONAL SOLIDIFICATION UNIT                      SP002    11114
185450
185450 THIS UNIT CONSISTS OF A FURNACE AND A CHILL UNIT. SPECIMENS ARE
185450 HEATED, MOVED THROUGH A THERMAL GRADIENT AREA AND THEN INTO A
185450 COOLING AREA.
185450
185450    CHILL UNIT DIMENSIONS..........0.6 IN(1.5CM)I.D.X8.0 IN(20CM)
185450                                   LONG
185450    CHILL CAPACITY.................1KW THERMAL
185450    HEATING UNIT DIMENSIONS........0.8 IN(2CM)I.D.X8IN(20CM) LONG
185450    HEATER CAPACITY................1KW THERMAL
185450    TEMPERATURE GRADIENT ADJUST
185450            RANGE..................5 TO 500F/IN (2 TO 200C/CM)
185450    HEATER MAX TEMPERATURE.........2900F(1600C)
185450    CHILL UNIT MIN TEMP............68 TO 77F (20 TO 25C)
185450    EXTERNAL SURFACE TEMP..........60 TO 110F (15 TO 50C)
185450
003110 ACOUSTIC MIXING AND DISPERSAL UNIT                   SP002    21235
003110
628010 ELECTROMAGNETIC MIXING AND DISPERSAL UNIT            SP002    21235
628010
419500 IR PYROMETER                                         SP002    21111
419500
419500 THE PYROMETER OPTICALLY SENSES THE INTENSITY OF RADIANT ENERGY
419500 EMITTED FROM THE SAMPLE SURFACE
419500
419500    TEMPERATURE RANGE ............. 104 TO 5400 F (40 TO 3000 C)
419500    SPECTRAL RESPONCE..............0.70 - 0.97 MICROMETERS
        CALIBRATION ACCURACY...............+/- 1% FULL SCALE
        REPEATABILITY......................+/- 3% FULL SCALE
419500
    PYROMETER INSTRUMENT CO        #PHOTO II          $3450            111
        RANGES........................... 1400 TO 2500F (760C TO 1400C)
                                          2400 TO 3400F (1300 TO 1900C)
                                          3200 TO 5800F(1800 TO 3200C)
                                          CAN OBTAIN 9000F (5000C)
        ACCURACY......................... 1/4%
        REPEATABILITY.................... 0.005C/HR DRIFT AT 1063C

    ANALOG DEVICES INC.            #ADC-9S            $79              111
        RESOLUTION                        8 BITS
        ERROR                             +/-0.2%
        CONVERSION TIME                   1 MILLISEC.

    ANALOG DEVICES INC.            #ADC-12QZ          $305             111
        RESOLUTION                        12 BITS
        ERROR                             +/-0.0125%
        CONVERSION TIME                   25MICROSEC.

    ANALOG DEVICES INC             #ADC-16Q           $1350            111
        RESOLUTION                        16BITS
        ERROR                             +/-0.0015%
        CONVERSION TIME                   40MICROSEC.

    TENNELEC                       #TC500             $6000            111
        CONVERSION TIME...................3 MICRO SEC
        CAPACITY......................... 2048 CHANNELS
        CONFIGURATION.................... COMPATIBLE WITH NIM

    TENNELEC                       #TC 520            $750             111
        CHANNELS......................... 8
        CHANNEL DWELL TIME............... 300NSEC
        CONFIGURATION.................... NIM COMPATIBLE

    ROHDE AND SCHWARZ              #UCM 210/1                          111
                                    (221.5603.02)
        ANALOG INPUT RANGE .............. +12 TO -12 VOLTS
        SAMPLING RATE ................... > 10000 MEAS/SEC (POSITIVE)
                                          > 17000 MEAS/SEC (NEGATIVE)
        DATA OUTPUT ..................... 3+1 DECADES (BCD CODE PARALLEL)
                                          0-1200 PULSES (SERIAL)

    PYRO OPTICAL                   #87                $495             111
        TEMPERATURE RANGES...............1400 TO 2200F (760 TO 1210C)
                                          1800 TO 3400F (982 TO 1875C
                                          3200 TO 5200F (1760 TO 2880C)

    HY-CAL                         #P-8403-B          $650             111
        ENERGY RANGE..................... 1 TO 100 SOLAR CONSTANTS
        VIEW ANGLES...................... 5.7 TO 180DEG
        OUTPUT........................... 5 OR 10MILLIVOLTS/ SOLAR CONST.

186000 ZONE REFINER                                         SP002    11112
186000
186000 THIS UNIT WILL HEAT, HOLD AND MANIPULATE A SPECIMEN FOR ZONE
186000 REFINING AND MOLTEN ZONE CRYSTAL GROWTH. IT WILL CAUSE A MOLTEN
186000 REGION TO TRAVERSE ALONG A LONG CYLINDRICAL ROD OF MATERIAL.
186000
186000    SPECIMEN SIZE..................4 TO 12 IN (10 TO 30 CM) LONG
                                         0.1 TO 0.5IN(0.25 TO 1.25CM) DIA
186000
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ORIGINAL PAGE IS OF POOR QUALITY

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186000     SCANNING DISTANCES.............UP TO 12IN(30CM)
186000     SCANNING SPEED.................UP TO 20IN/MIN (50CM/MIN)
186000     SPECIMEN ROTATION..............0 TO 60 RPM
186000     OPERATING TEMPERATURE..........575 TO 2900F (300 TO 1600C)
186000
   MATERIALS RESEARCH CORP         #EBZ-6000              $2500        112
        USABLE SPECIMEN SIZE ............ 10-30 CM LONG, 0.23-1.0 CM DIA
        BEAM SOURCE ..................... WORK ACCELERATED, ANNULAR FILA-
                                          MENT WITH BEAM FOCUSING SUPER-
                                          STRUCTURE
        POWER SUPPLY .................... 5 KV, 400 MA DC
        ZONE TRAVEL ..................... 23 CM DISPLACEMENT
                                          2.5 - 25 CM/HR WITH AUTOMATIC
                                          SHUT-OFF AT END OF SCAN

   LINDBERG                        #54000                 $675         111
        THREE ZONE CONTROL
        TEMPERATURE(MAX)................. 2200F (1200C)
        ZONE DIMENSIONS.................. 2-6IN(15.7CM)ENDS,12IN(30.4CM)
                                          CENTER SECTION

627010 FEED AND CRYSTAL HOLDER                                SP002   21113
627010
435000 RESIDUAL GAS ANALYZER                                  SP002   21111
435000
435000 IDENTIFY TYPE AND QUANTITY OF GAS REMAINING IN A PROCESSING
435000 CHAMBER OR GENERATED DURING A PROCESS. THE ANALYZER IS ALSO USED
435000 IN THE LEVITATION SUBELEMENT. THE UNIT MUST HAVE A TUNABLE MASS
435000 UNIT SECTION FOR LEAK DETECTION, BE A QUADROUPOLE TYPE INSTRUMENT
435000 CAPABLE OF SEPARATING MASSES. THE INSTRUMENT MUST ACT AS A
435000 PARTIAL AND TOTAL PRESSURE ANALYZER AS WELL AS GAS ANALYZER.
435000
435000     MASS RANGE RESOLUTION..........      UP TO 200AMU
435000     DETAILED SPECTRAL ANAL MASS RANGES.....1-50 AND 40-65AMU
435000     SCOPE SCAN SPEED...............      VARIABLE  3MS TO 300S
435000     DATA OUTPUT....................      VISUAL ANALOG
435000                                          ANALOG
435000                                          DIGITAL
435000     USEFUL PRESSURE RANGE..........1.0E-5 PSI(7.5E-2N/M2)
435000                           TO 1.0E-11 PSI (7.5E-8N/M2)
435000     MASS SEPARATION CAPABILITY....         1AMU
435000     MIN DETECTABLE PARTIAL PRESSURE..2E-12 PSI (1.5E-8N/M2)
435000     MIN DETECTABLE TOTAL PRESSURE.......1E-10 PSI (7.5E-7N/M2)
435000
   PEARLESS INSTRUMENT CO. INC.  #210                     $5000        111
        STD. GASES ...................... CO,CO2,H2O,H2S,HC,NH3,
                                          NO,N2O,NO2,O3,SO2,
                                          (ANY GAS MAY BE DEFINED
                                          BY KNOWN ABSORPTION BAND
                                          IN RANGE: 200 TO 10000 HM
        RANGES .......................... 0-100 OR 0-1000 PPM
        FLOW ............................ 0.5 TO 1 CU.FT./MIN.
        TEMPERATURE ..................... TO 200F
        RESPONSE TIME ................... 3 SEC. AT 90% READING
        NOTE:                             EACH UNIT HANDLES 2 GASES
                                          OPERATORS CONSOLE ALSO
                                          REQD

   VEECO                           #SPI-10                $4000        111
        SPECTRAL ANALYSIS ............... 1-50 AND 40-65 AMU (DETAILED)
                                          1-200 AMV (GENERAL)
        RESOLUTION ...................... VALLEY < 10% OF THE SUM OF ADJ
                                          PEAKS FOR 1 AMU APART THROUGH-
                                          OUT 1-50 AND 40-65 AML RANGES
        MINIMUM DETECTABLE PRESSURE .... 1.3E-8 N/SQ M (PARTIAL)
                                          6.5E-7 N/SQ M (TOTAL)
        USEFUL PRESSURE RANGE ........... 6.5E-8 N/SQ M
        SCOPE SCAN SPEED ................ 3 MS TO 300 SEC (VARIABLE)

   BALZERS                         QMG 101                $10000       111
        TYPE............................. QUADRUPOLE
        PRESSURE/GAS ANALYZER............ YES
        MASS RANGE....................... 1 TO 400 AMU
        MIN DETECTABLE PRESSURE.......... E-14 TORR
        MAX PERMISSIBLE PRESSURE......... E-4 TORR
        RESOLUTION....................... 10 PER CENT VALLEY
        SCAN SPEED.................... .25-2500MS PER MASS UNIT
        WEIGHT CONTROL UNIT.............. 25.8KG
        WEIGHT ANALYZER.................. 6.8KG
406500 RF INDUCTION PWR COND. (MIXING & DISPERSAL)            SP002   21111
406500
408000 LOW VOLT/HIGH AMP POWER CONDITIONER (10KW)             SP002   31111
408000
   SORENSEN                        #DCR40-500A            $4200        311
        OUTPUT VOLTAGE................... 0 - 40 VOLTS
        INPUT VOLTAGE ................... 414  TO 506 VOLTS
        OUTPUT CURRENT................... 550 AMPS DC AT 30C
        INPUT CURRENT.................... 60 AMPS AC-3PHASE
        TRANSIENT RESPONCE...............
        CONSTANT VOLTAGE REGULATION...... +/-0.10% OR+/-15MV2
        CONSTANT CURRENT REGULATION...... +/-1000MA
        WEIGHT........................... 805LBS (320KG)
        SIZE............................. 25X42X23IN
        MOUNT............................ FLOOR

419500 TWO - COLOR PYROMETER                                  SP002   21111
419500
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184500 RESISTANCE HEATER (CONTACT)                              SP002   21111
184500
184500 HEATING ELEMENT WHICH HEATS ENCAPSULATED SAMPLES BY PASSING A
184500 CURRENT THROUGH IT
184500
184500    POWER..........................4KW SUSTAINED, 9KW PEAK
184500    TEMPERATURE(MAX)...............2900F (1600C)
184500    ATMOSPHERE.....................INERT GAS OR VACUUM
184500
184000 MICROWAVE HEATER                                         SP002   31235
184000
184000 PROVIDE MICROWAVE ENERGY SOURCE FOR SPECIMEN HEATING
184000
184000    TEMPERATURE(MAX)...............18000F (10,000C)
184000    POWER(MAX).....................2KW
184000    FREQUENCY RANGE(MAX)...........UP TO 1E10 HZ
184000    OPERATIONAL ATMOSPHERE.........ANY BUT VACUUM
184000
186000 GRADIENT FURNACE                                         SP002   11113
186000
628020 MECHANICAL MIXING AND DISPERSAL UNIT                     SP002   11235
628020
320000 THREE AXIS MANIPULATOR                                   SP002   21132
320000
627020 PIEZOELECTRIC DRIVE                                      SP002   21114
627020
527000 VACUUM/PRESSURE REGULATOR                                SP002   31111
527000
527000 THE UNIT REGULATES THE PRESSURE IN THE PROCESSING CHAMBERS BY
527000 ADMITTING FLUID FROM A FLUID SUPPLY CONTAINER. THIS UNIT IS ALSO
527000 EMPLOYED ON THE GENERAL PURPOSE AND LEVITATION SUBELEMENTS
527000
527000    PRESSURE-ABSOLUTE ............. 0.1 TO 1000 PSIA
527000
417500 HIGH VACUUM PUMP                                         SP002   21111
417500
417500 UNIT IS USED IN CONCERT WITH MOLECULAR SIEVE. IT IS USED WITH
417500 THE SPACE VACUUM TO BLEED DOWN OVENS. THIS UNIT IS ALSO USED ON
417500 THE LEVITATION SUBELEMENT.
417500
417500    PRESSURE-ABSOLUTE ............. AMBIENT TO 0.1 PSIA
417500
    DUO-SEAL                       #1400              $136         111
                                                                   111
         VACUUM LEVEL..................... 0.05MICRON(0.00005TORR)
         CAPACITY......................... 0.9CFM (25LITERS/MIN)

    PRECISION                      #35                $135         111
         VACUUM LEVEL..................... 15 MICRONS
         CAPACITY......................... 1.2CFM (35 LITERS/MIN)

524500 VACUUM/PRESSURE MEASUREMENT UNIT                         SP002   31111
524500
524500 MEASURES PRESSURES IN PROCESS CHAMBERS. UNIT IS ALSO REQUIRED
524500 FOR GENERAL PURPOSE AND LEVITATION SUBELEMENTS.
524500
524500    PRESSURE-ABSOLUTE ............. AMBIENT TO 0.01 PSIA
524500
407500 HIGH VOLTAGE POWER CONDITIONER (17KV)                    SP002   21111
407500
406500 RF INDUCTION POWER CONDITIONER (2KHZ - 2MHZ)             SP002   21111
406500
    SORENSEN                       #1020-30+L2        $1220        111
         INCLUDES OUTPUT RIPPLE ATTENUATOR FROM 2.0%RMS TO 0.01%RMS
         OUTPUT VOLTAGE................... 0 TO 20 KV
         INPUT VOLTAGE.................... 105 TO 125 VAC
         OUTPUT CURRENT................... 20 MILLIAMPS
         INPUT CURRENT.................... 10 AMPS AC ,1 PHASE
         FREQUENCY........................ 57 TO 63 HZ
         WEIGHT........................... 80LBS(32KG)
         SIZE............................. 19X 8 3/4X15 5/8IN
         MOUNT............................ RACK

    SORENSON                       #200               $800         111
         OUTPUT VOLTAGE................... 0 TO 30, 0 TO 15, 0 TO 7.5KV
         INPUT VOLTAGE.................... 105 TO 125 VAC 1PHASE
         OUTPUT CURRENT................... 0-3.0-6.0-12MILLIAMPS
         INPUT  CURRENT................... 1.75AMPS AC,1 PHASE
         WEIGHT........................... 55
         SIZE............................. 9X11X15 3/4 IN
         CONFIGURATION.................... PORTABLE

186000 THERMAL OVEN                                             SP003   21111
186000
    TENNY ENGINEERING INC          #BLT TO SPEC                    115
         PRESSURE ........................ VACUUM TO 1000 PSIG
         TEMPERATURE ..................... -100 TO 600 F

    FREAS  PRECISION               #605A              $725         111
         TEMPERATURE(MAX) ................ 660F(350C)
         POWER ........................... 3100W
         VOLUME .......................... 1.35CU.FT(0.04CU.M.)
         MOUNT ........................... BENCH

    NAPCO                          #620               $495         111
         TEMPERATURE(MAX) ................ 390F(200C)
         MOUNT ........................... BENCH
         VOLUME .......................... 3.8CU.FT.(0.1CU.M)
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BLUE M                          #POM-143-A-1        $665          111
     TEMPERATURE(MAX) ................ 450F(230C)
     MOUNT............................ BENCH

THELCO                          #18                 $395          111
     TEMPERATURE(MAX)................. 440F(225C)
     POWER............................ 1050W
     MOUNT............................ BENCH
     VOLUME........................... 1.35CU.FT(0.04CU.M)

499600 IR SPECTROMETER                                    SP003   11111
499600
499600 INFRARED ANALYSIS OF CONSTITUENTS IN GASESOUS OR LIQUID STREAMS.
499600
499600    RANGE ...................... 10 TO 100 MICRONS
499600    RESOLUTION ................. +/- 0.5 MICRONS
499600    RESPONSE TIME .............. 2 SECONDS
499600
    BECKMAN INSTRUMENTS         #4250            $11500           111
     RANGE ........................... 4000-200CM-1(2.5-50MICRONS)
     RESOLUTION ...................... .5-1.4CM-1
     ACCURACY ........................ +/-1.0%
     SCAN SPEED ...................... 1000 TO 2CM-1/MIN
     SIZE ............................ 48X24X22 INCHES 122X61X56 CM
     WEIGHT .......................... 210 LBS (95KG)

419500 LASER PYROMETER                                    SP003   21235
419500
    LASER PRECISION CORP        #1120               $970
     ELEMENT DIAMETER..................2.0MM
     CURRENT RESPONSIBILITY............0.125 MICROAMPS/WATT
     SATURATION POWER..................800 MILLIWATTS
     SATURATION ENERGY.................6.4 MILLIJOULES

074700 GAS CHROMATOGRAPH                                  SP003   21111
074700
074700 THE FUNCTIONAL REQUIREMENTS OF THE EQUIPMENT ARE TO ANALYZE THE
074700 ATMOSPHERIC COMPOSITION AND THE IMPURITY CONCENTRATION CONTAINED
074700 WITHIN THE EXPERIMENTS' EQUIPMENT ENCLOSURES. THIS ELEMENT IS
074700 ALSO USED ON THE LEVITATION SUBELEMENT.
074700
074700    FLOW RATE .................. 10 ML/MINUTE
074700    SENSITIVITY................. 0.1 PPM
074700
    BECKMAN INSTRUMENTS         #6700               $8000
     SENSITIVITY.......................1 +0 5 PPM
     OPERATING TEMP....................55 +0 225C
     TEMPERATURE CONTROL...............+/- 0.05C

    BECKMAN                     #GC-2A              $2050         111
     DETECTOR ........................ THERMAL CONDUCTIVITY
     TEMPERATURE CONTROL RANGE ....... 40C TO 240C
     CONTROL ACCURACY ................ +/-0.1
    CARLE INSTRUMENTS, INC.     #950C               $1185
     TEMPERATURE RANGE ............... AMBIENT TO 200 DEG C
     DETECTOR ........................ DUEL FEED SINGLE HYDROGEN FLAME
     SENSITIVITY ..................... 5E-12 AMPERES
     POWER REQUIREMENTS .............. 115 VAC, 50 TO 60 HZ

    CARLE INSTRUMENTS INC       #8001               $675          111
     ACCURACY ........................ +/- 0.5 PERCENT
     GASES DETECTED .................. CO, CO2, N2, AR, O2, CH4
     SAMPLE SIZE ..................... 1 MM
     REPETITIVE SAMPLING TIME ........ 5 TO 60 MIN.

    CARLE INSTRUMENTS, INC.     #AGC-311            $2675
     CONTROL SENSITIVITY ............. < 0.001 DEG C
     TEMPERATURE RANGE ............... TO 399 DEG C (1 DEG INCREMENTS)
     HEAT CAPACITY-TOTAL ............. 600 WATTS
     INLETS .......................... DUAL ON-COLUMN
     IONIZATION DETECTORS ............ HYDROGEN FLAME
     VALVING ......................... MICRO OR MINI VOLUME VALVES
     WEIGHT........................... 53 POUNDS
     POWER REQUIREMENTS .............. 115 VAC

    VARIAN AEROGRAPH            #1520               $5200         112
     COLUMN OVEN TEMP................. -99 TO 399 C
     TEMP STABILITY................... BETTER THAN .1 PER CENT
     FLAME DET SENSITIVITY............ .015 COULOMBS/GRAM
     MIN DETECTABILITY................ 5 E-12 GRAM/SEC
     NOISE............................ LESS THAN 3XE-14 A
     AMPLIFIER........................ SOLID STATE
     DIMENSIONS....................... 20X18X22 INCHES

    BECKMAN INSTRUMENTS         #6800               $7350         111
     CARRIER ......................... H2
     DETECTOR ........................ FLAME
     RANGE ........................... 0-1 PPM FULL SCALE
     ANALYSIS RATE ................... 4 TO 6/HR (SELECTABLE)
     REPEATABILITY ................... .5% OF FS
     LINEARITY ....................... 1% OF FS
     ZERO DRIFT....................... AUTOMATIC ZERO COMPENSATION
     DIMESNIONS ...................... 17X40X20 INCHES
     WEIGHT .......................... 250 LBS (SHIPPING)
     POWER ........................... 107-127V 50/60 HZ 500W

094000 TIME LAPSE HIGH SPEED CAMERA                       SP001   21111
094000
094000 CAMERA ALSO USED IN LEVITATION SUBELEMENT
094000
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C-4

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    J A MAURER                      #500              $M - 9000       111
        FILM SIZE ........................ 5 IN MS 33523
        FORMAT ........................... 4.5 X 4.5 IN
        SHUTTER .......................... 1/8000 TO 1/200 SEC
        MODE ............................. PULSE OR AUTOCYCLE
        FRAME RATE ....................... UP TO 5 FR/SEC
        FOCAL LENGTH ..................... 24 IN
        NO REQD (LENSES) ................. 2
        RESOLUTION ....................... 104 L/MM AWAR
        MAGAZINE ......................... 250 FT 5 IN FILM
        MIL-SPEC  /  AIRBORNE

305000 NUCLEAR PARTICLE COUNTING UNIT                         SP001   11111
305000
305000 CAPABILITY TO DISCRIMINATE AND COUNT ALPHA, BETA, GAMMA, X-RAYS
305000 AND K-ELECTRONS.
305000
305000    COUNTING RATE .................. 3.5E+06 C/M
305000    RESOLUTION LOSS ................ 1 %/3E+06 C/M
305000    PLATEAU CHARACTER
305000                ALPHA .............. 900-1200 V @ 1 %/100V
305000            BETA-GAMMA ............. 1700-1900 V @ 1 %/100 V
305000    PRECISION ...................... +/- 0.1 % FS
305000    TIMER .......................... 0.05 TO 2160 MINUTES
305000
    SCINTIBLOC                      #127SE102                         111
        ENERGY RESOLUTION FOR CS137..... 9.5% OR BETTER
        GAMMA RAY ENERGY................ 10KEV TO SEVERAL MEV

    JOHNSTON LABORATORIES           #MM-2;PAD:HV-4R                   111
        SYSTEM CONSIST OF FOCUSED MESH ELECTRON MULTIPLIER(#MM-2)
        PREAMPLIFIER-AMPLIFIER-DISCRIMINATOR(#PAD)AND REGULATED HIGH
        VOLTAGE POWER SUPPLY(HV-4R)
        ELECTRON GAIN................... 10E6 AJ 3KV
        MAX COUNT RATE.................. 10E8 PER SEC
        DETECTION EFFICIENCY............ ELECTRON- 90% AT 200E:V.
                                         ION- 90% AT 3000E.V.

    HEWLETT PACKARD                 #5880A/5583A/   $1150/$650        112
                                     5590A/5554     $1875/$360
                                    /5582A             $750
        CONFIGURATION .................. MULTI-UNIT BENCH EQUIP
        RADIATION DETECTED ............. ALPHA, BETA, X-RAY, GAMMA OR
                                         NEUTRON
        RATE MEASUREMENT RANGE ......... 0 TO 1000 R/HR

414500 RESISTANCE THERMOMETER                                 SP003   NI111
414500
414500 THERMOCOUPLES                                          SP003   NI111
414500
184500 RESISTANCE HEATER (NON-CONTACT)                        SP004   11111
184500
184500 TUBE TYPE HEATING UNIT FOR USE IN CHEST-GENERAL PURPOSE ENCLOSURE
184500 OR HOT WALL FURNACE
184500
184500    POWER...........................4KW SUSTAINED, 9KW PEAK
184500    TEMPERATURE(MAX)................2900F (1600C)
184500    SPECIMEN SIZE...................4IN (10CM)LONG X 0.75 IN(2CM)
184500                                    DIA.
184500
183500 RF INDUCTION COILS                                     SP004   11111
183500
183500 PROVIDE NON-CONTACT HEATING
183500
183500    FREQUENCY RANGE.................2KHZ TO 2MHZ
183500    OPERATIONAL ATMOSPHERE..........ANY
183500
605003 ELECTRON BEAM SOURCE                                   SP004   11114
605003
605003 THE ELECTRON BEAM SOURCE WILL BE USED TO HEAT SAMPLES THAT
605003 REQUIRE NON-CONTACT HEATING. THE UNIT WILL BE USED IN THE CHEST-
605003 GENERAL PURPOSE ENCLOSURE
605003
605003    DELIVERABLE POWER...............3 - 4 KW
605003    INPUT POWER.....................6KW
605003    TEMPERATURE.....................4500F (2500C)
605003    MAXIMUM SAMPLE SIZE.............0.15 CU.IN. (2CC)
605003    OPERATING PRESSURE..............1E-10 PSI (7.5E-7N/M2)
605003
227000 LASER SOURCE                                           SP004   11111
227000
227000 PROVIDE HEAT TRANSMITTED TO A SPECIMEN BY LASER BEAM. CONCEPT
227000 PROVIDES HEATING WITHOUT CONTAMINATING SPECIMEN. UNIT IS USED
227000 IN CONJUNCTION WITH CHEST-GENERAL PURPOSE ENCLOSURE
227000
227000    POWER...........................6KW
227000    COOLING CAPACITY................7.5KW
227000    LASER TYPE......................ANY OF FOLLOWING FIVE:
227000           .........................CONTINUOUS WAVE HYDROGEN-FLOUR-
227000                                    INE CHEMICAL LASER, IR OUTPUT
227000           .........................CONTINUOUS WAVE FORCED CONVEC-
227000                                    TION CO2, IR OUTPUT
227000           .........................CONTINUOUS WAVE CO-C2-H2O-HE
227000                                    CHEMICAL LASER, IR OUTPUT
227000           .........................PULSED TEA CO2, IR OUTPUT
227000           .........................PULSED TEA XENON, UV OUTPUT
227000
    AMERICAN LASER CORP             #90               $17950          111
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        TYPE............................ GAS (CO2)
        WAVELENGTH...................... 10.6 MICRONS
        POWER........................... 300 TEM
        BEAM DIVERGENCE................. 1.7 MRAD
        RESONANT CAVITY DIMENSIONS...... 110 INCHES
        Q SWITCH TYPE................... MECH
        COOLING......................... WATER

626010 MINIMUM B WITH RF HEATING                        SP004   11235
626010
609001 ELECTROMAGNETIC POSITIONING COILS AND DETECTOR   SP004   11115
609001
609001 PROVIDE ALTERNATING ELECTROMAGNETIC FIELD FOR CONTACTLESS
609001 POSITION CONTROL.
609001
609001    MAGNETIC PRESSURE ............. 1.4 PSI (10 KN/SQ M)
609001
609002 ELECTROSTATIC POSITIONING PROBES AND DETECTOR    SP004   11115
609002
609002 ELECTROSTATIC FIELDS USED FOR POSITIONING EXPERIMENT SPECIMEN
609002 SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.
609002
609002    CHAMBER PRESSURE .............. > 0.14 PSI (1 KN/SQ M)
609002                                    < 2E-06 PSI (0.01 N/SQ M)
609002
609002    CONFIGURATION ................. IN APEX OF TETRAHEDRON
609002
003210 ACOUSTIC TRANSDUCER AND DETECTOR.                SP004   11111
003210
003210 USE OF SOUND PRESSURE WAVES TO POSITION EXPERIMENT SPECIMEN
003210 SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.
003210
003210    CHAMBER PRESSURE .............. > 0.14 PSI
003210                                    (1 KN/SQ M)
003210                                    < 2E-06 PSI
003210                                    (0.01 N/SQ M)
003210    CONFIGURATION ................. IN APEX OF TETRAHEDRON
003210
607001 GAS JET POSITIONING PROBES AND DETECTORS         SP004   11115
607001
607001 USE OF GAS JETS TO POSITION SPECIMEN DURING EXPERIMENT PRO-
607001 CEDURES SUCH AS TO MAINTAIN CONTACTLESS POSITION CONTROL.
607001
607001    GAS FILTER .................... 8E-06 INCHES (0.2 MICROMETERS)
607001    GASES ......................... HELIUM, HYDROGEN, OXYGEN
607001    CONFIGURATION ................. JET PAIR IN APEX OF TETRAHEDRON
607001    GAS PRESSURE MINIMUM .......... 0.014 PSIA (100 N/SQ M)
607001
092600 DIRECTIONAL CALORIMETER                          SP004   11113
092600
092600 THE DIRECTIONAL CALORIMETER WILL BE COMPOSED OF A PYROELECTRIC
092600 IR DETECTOR, DETECTOR PREAMPLIFIER, OPTICAL MODULATOR (LIGHT
092600 CHOPPER) AND DEMODULATOR (RECTIFIER). IT WILL BE USED TO
092600 DETERMINE THE BEGINNING OF SOLIDIFICATION BY OBSERVING THE
092600 ACCOMPANYING THERMAL ARREST AND WILL MEASURE THE RATE OF RELEASE
092600 OF THE HEAT OF FUSION.
092600
     HY-CAL ENGINEERING            #C-119-A-10-003-003   $250         113
        FLUX RANGE .................... 0-100 W/SQ CM (SOURCE FLUX)
        SPECTRAL RESPONSE ............. 0.5-40 MICRON
        RESPONSE RATE ................. 0.25 SEC
        FIELD-OF-VIEW ................. 1.5 CM DIA, 0.25 RAD DIVERGENCE
        ACCURACY ...................... +/- 3 PERCENT OF READING

     LASER PRECISION CORP          #KT-2000/KTI-200 $150-500          113
        SPECTRAL RESPONSE ............. .5 TO 75 MICRON
        FREQUENCY RESPONSE ............ 2 TO 900 HZ
        FLUX RANGE .................... 0 TO 10 W/SQ CM (INCIDENT)

092600 PYROLYTIC IR DETECTOR SPECTRAL
092600    RANGE.........................2E-5 TO 3E-3 IN(0.5 TO 75
092600                                 MICROMETERS)
092600    INCIDENT FLUX RANGE...........6.5W/IN2 (1 - 10W/CM2)
092600
320000 MECHANICAL SAMPLE PLACEMENT AND RETRIEVAL        SP004   11113
320000
629020 LIQUID SYRINGE DISPENSER                         SP004   21113
629020
629010 INERTIAL INJECTOR                                SP004   11235
629010
410000 VACUUM CATCH TUBE                                SP004   11235
410000
630010 SOLID SAMPLE STORAGE                             SP004   11112
630010
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LIFE SCIENCES

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095050 CAMERA - STILL FILM (CORE)                          LS900   11111
095050
095050 STILL PHOTOGRAPHIC CAPABILITY WHICH IS SHARED WITH OTHER EXPERI-
095050 MENTS. CAMERA HAS INTERCHANGEABLE LENS AND IS COMPATIBLE WITH
095050 EQUIPMENT SUCH AS MICROSCOPES AND OSCILLOSCOPES.
095050
095050    FILM FORMAT .................... 35 MM
095050    LENS ........................... 50 MM, F1.2
095050    VIEW ANGLE ..................... 41 DEGREES
095050    LENS ........................... 35 MM, F1.8
095050    VIEW ANGLE ..................... 64 DEGREES
095050    SHUTTER SPEED .................. B TO 1/500 SEC
095050    VIEWING ........................ THRU LENS
095050    FOCUS .......................... SPLIT IMAGE
095050
    HONEYWELL INC               #SPOTOMATIC F          $638          111
       LENS .......................... 55 MM, F/1.8 TAKUMAR
                                       35 MM, F/2.0 TO F/16 TAKUMAR
       SHUTTER SPEEDS ................ 1/1000 SEC TO TIMER
       VIEWING ....................... THRU LENS
-
095050 CAMERA - STILL POLAROID (CORE)                      LS0C2   41111
095050
095050 POLAROID PHOTOGRAPHIC CAPABILITY SHARED WITH MOST EXPERIMENTS
095050 ALSO ADAPTABLE WITH MICROSCOPE AND OSCILLOSCOPE INTERFACES.
095050
095050    FILM FORMAT .................... POLAROID 107 BLACK/WHITE
095050                ................... 3.25X4.25 IN (82.55X192.95 MM)
095050    LENS ........................... 56 MM, F3.5 TO F22
095050    SHUTTER SPEEDS ................. B TO 1/60 SEC.
095050    RANGE FINDER ................... SPLIT IMAGE
095050    VIEWING ........................ THRU LENS
095050    FIELD OF VIEW .................. 40 DEGREES
095050
    TEKTRONIX INC               #C-12                  $590          111
       LENS .......................... 75 MM
       STOP .......................... F/1.9 TO F/16
       MAGNIFICATION ................. 0.85
       LENS SPEED .................... 1 TO 1/130 SEC MECH
                                       4 TO 1/60 SEC ELECT
       FILM TYPE...................... POLAROID

    TEKTRONIX                   #C30                   $525
       MAXIMUM RELATIVE APERTURE...... F/1.9
       MAGNIFICATION.................. 0.7 TO 1.5
       RELATIVE SPEED................. 1.0
       FIELD OF VIEW.................. 3.15X3.93IN (8X10CM)
       FILM TYPE...................... POLAROID

    HEWLETT-PACKARD             #198                   $420
       MAXIMUM RELATIVE APERTURE...... F/3.5
       MAGNIFICATION.................. 1:0.85
       SPEED.......................... B TO 1/60 SEC
       LENS........................... 75MM
       FILM TYPE...................... POLAROID

    HEWLETT-PACKARD             #155A                  $1025
       MAXIMUM RELATIVE APERTURE...... F/1.3
       MAGNIFICATION.................. 1:0.5
       SPEED.......................... B TO 1/30 SEC
       LENS........................... 80MM
       FILM TYPE...................... POLAROID

425500 RECORDER - STRIP CHART (CORE)                       LS1013  11111
425500
425500 HARD RECORD OF APPROPRIATE LIFE SCIENCES DATA.
425500
425500    FREQUENCY RESPONSE ............ DC TO 150 HZ
425500    SENSITIVITY ................... 0.1 TO 50 MV/MM
425500    CHANNELS ...................... 8
425500    CHART SPEED ................... 1 TO 500 MM/SEC
425500    WRITING METHOD ................ THERMAL
425500
    HEWLETT PACKARD             #7100BR WITH OPTION  $2295           111
                                 019 AND 023.
                                 17500A PLUG-IN
       CHANNELS ...................... 2 CHANNELS PLUS EVENT MARKER ON
                                       BOTH SIDES
       WRITING METHOD ................ ELECTRIC
       ACCURACY ...................... +/- 0.2 % FS
       VOLTAGE SPAN .................. 5 MV TO 100 V

    HEWLETT PACKARD             #7702B/8801A          $2750          111
       FREQUENCY RESPONSE ............ DC TO 125 HZ
       WRITING METHOD ................ THERMAL
       SENSITIVITY ................... 5 MV/DIV
       CHANNELS ...................... 2 CHANNELS TIMER/MARKER
       VOLTAGE RANGE ................. 5 MV TO 5 V PER DIV
       ACCURACY ...................... +/- 1 %

    HEWLETT PACKARD             #77C8B/8802A          $8975
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    CONFIGURATION ..................... RACK MOUNTED
    CHART SPEED ....................... 0.25, 0.5, 1, 2.5, 5, 10, 25,
                                        50, 100 MM/SEC
    FREQUENCY RESPONSE ................ 150 HZ
    CHANNELS .......................... 8
    WRITING METHOD .................... THERMAL
    INPUT RANGES ...................... 1, 2, 5, 10, 20, 50, 100, 200,
                                        500, 1000 MV/DIV
    ACCURACY .......................... +/- 1%

HONEYWELL                  #1912                $7700       111
    PAPER WIDTH........................ 12IN
    CHANNELS........................... 24
    FREQUENCY RESPONCE................. DC TO 25KHZ
    PAPER SPEED........................ 200IPS
    SPEED VARIATION.................... 15 FORWARD, 12 REVERSE SPEEDS
    MOUNT.............................. RACK

BECKMAN INSTRUMENTS        #R                   $10750      111
    BANDWIDTH.......................... DC TO 130HZ
          ............................. 5000 HZ WITH PR-500TAPE REC
    CHANNELS .......................... 1 TO 8 UP TO 24 SPEC CRDER
    REC FORMAT ........................ THERMAL RECTILINEAR
    CHART SPEED ....................... 0.1 TO 25 CM/SEC OTHERS AVAIL
    EVENT MARKERS .....................  2 (OPTION)
    DIMENSIONS ........................  69.5X21.5X22.5 INCHES
    POWER .............................  120V 50/60 HZ 250W

HONEYWELL                  #1856                $7500       111
    HARDCOPY RECORDS FROM INFRARED, VIDEO AND SONIC SCANNERS, RADAR
    SYSTEMS AND REAL TIME SPECTRUM ANALYZERS
    RESOLUTION......................... 1000 ELEMENTS PER SWEEP
    RECORDING RATE..................... 4 MILLION BPS
    SPOT SIZE.......................... 0.005IN
    SWEEP SPEED........................ UP TO 20,000 LINES PER SEC
    FIBER OPTIC CRT
HONEYWELL                  #15CPR               $3300       111
    DATA CHANNELS...................... 24
    EVENT CHANNELS..................... 4
    FREQUENCY RESPONCE................. DC TO 25KHZ
    PAPER   SPEED...................... 0.1 TO 120 IPS
    MOUNT.............................. RACK
    PAPER WIDTH........................ 8IN

BECKMAN INSTRUMENTS        #RP                  $3020       111
    FREQUENCY ......................... DC TO 130 HZ
    CHANNELS .......................... EVENT, TIME, 2 DATA
    WRITING METHOD .................... THERMAL
    SENSITIVITY ....................... 1 MUV/MM TO 5 V/MM
    RESPONSE TIME ..................... 5 MSEC FOR 10-90% OF 50 MM PEN
                                        TR
    CHART SPEED ....................... 1 TO 250 MM/SEC
    IRIG OUTPUT ....................... OPTIONAL

399600 OSCILLOSCOPE - PERSISTENT CRT (CORE)             L5976   11111
399600
399600 ELECTRONIC MONITOR AND DATA MEASUREMENT CAPABILITY OF LIFE
399600 SCIENCE EXPERIMENT EQUIPMENT WITH A SCREEN HAVING LONG TERM
399600 RETENTION.
399600
399600    BANDWIDTH ....................... DC TO 5 MHZ (MINIMUM)
399600    CHANNELS ........................ 2
399600    DEFLECTION FACTOR ............... 1 MV TO 10 V PER DIVISION
399600    PHOTOGRAPHIC CAPABILITY ......... YES
399600    PERSISTENCE ..................... UP TO 6 HOURS
399600
HEWLETT-PACKARD            #132A                $1900       111
    BANDWIDTH ......................... DC TO 500KHZ
    SENSITIVITY ....................... 100 MICROVOLTS/CM
    INDEPENDENT BEAMS ................. 2
    WEIGHT ............................ 43 POUNDS

HEWLETT PACKARD            #141B/1409A/1421A    $2605       111
    BANDWIDTH ......................... 5 MHZ
    DEFLECTION FACTOR ................. 5 MV/DIV
    CHANNELS .......................... 2
    PERSISTANCE ....................... 0.2 SEC TO >1 MINUTE (VARIABLE)

TEKTRONIX INC              #7313/7A18 PLUG-IN/  $4300       111
                            7B70 PLUG-IN
    BANDWIDTH ......................... DC TO 80 MHZ
    CHANNELS .......................... 2
    DEFLECTION FACTOR ................. 5 MV/DIV TO 5 V/DIV
    TIMEBASE .......................... 2 NS/DIV TO 5 S/DIV
    MAX VIEWING TIME .................. 4 HOURS
    MAX STORED WRITING SPEED .......... 5000 DIV/MS
    TYPE OF STORAGE ................... SPLIT SCREEN BISTABLE

TEKTRONIX INC              #R5040/3A6 PLUG-IN/  $2340       111
                            3B4 PLUG-IN
    BANDWIDTH ......................... DC TO 10 MHZ
    CHANNELS .......................... 2
    DEFLECTION FACTOR ................. 10 MV/DIV TO 10 V/DIV
    TIMEBASE .......................... 50 NS/DIV TO 5 S/DIV
    MAX VIEWING TIME .................. 1 HOUR
    MAX STORED WRITING SPEED .......... 500 DIV/MS
    TYPE OF STORAGE ................... SPLIT SCREEN BISTABLE
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263000 MICROSCOPE, DISSECTING                                 LS1004    11111
263000
263000 PERMIT DETAIL DISSECTING OF BIOLOGICAL SPECIMENS SUCH AS PLANTS,
263000 ANIMAL TISSUE AND ORGANS
263000
263000    STEREO EYEPIECE
263000    ADJUSTABLE BRIGHT AND DARK FIELD ILLUMINATION
263000
   BAUSCH - LOMB INC.          #SSM-15                $60           111
      MAGNIFICATION ................... 15X
      IPD ADJUST. RANGE ............... 45-75MM
      MAX. SPECIMEN THICKNESS ......... 0.875IN.
      NUMERICAL APERTURE .............. 0.042
      MIN. RESOLVING POWER..............60 LINES/MM
      FIELD OF VIEW ................... 8.0 MM
      CONVERGENCE ANGLE(IPD) .......... 10 DEG. AT 45MM
                                        15 DEG. AT 75MM

   OLYMPUS OPTICAL CO LTD      #JM-TR                 $900          111
      CONFIGURATION ................... LOOSE EQUIP
      TYPE ............................ DARKFIELD STEREO
      MAIN BODY ....................... TRINOCULAR TUBE INCLUDING 45
                                        DEG INCLINED BINOCULAR TUBE
                                        PLUS VERTICAL PHOTO TUBE
      MAGNIFICATION RANGE ............. 6.3X TO 80X
      WORKING DISTANCE ................ 86 MM
      APERTURE IRIS DIAPHRAGM ......... 2 TO 40 MM (ADJUSTABLE)
      CAMERA ATTACHMENT ............... POLAROID, 4X5 SHEET FILM, 35 MM

   AMERICAN OPTICAL            #58M-03                $620          111
      EYEPIECES........................ 10X,15X WIDEFIELD
      MAGNIFICATION.................... 7,10,15,20,25,30,40,50,60,80X
      WORKING DISTANCE................. 1.5,4 INCHES

263100 MICROSCOPE, COMPOUND                                   LS1005    11111
263100
263100 GENERAL PURPOSE BINOCULAR MICROSCOPE FOR MICROSCOPIC STUDIES OF
263100 TISSUES
263100
263100    MAGNIFICATION.................10X TO 100X
263100    PHOTOGRAPHIC CAPABILITY.......POLAROID FILM
263100    LIGHTING......................DARK FIELD OR LIGHT FIELD AND
263100                                  PHASE CONTROL
263100
   AMERICAN OPTICAL            #SERIES V20            $2035         111
      EYEPIECES........................ 10X (SUPPLIED) 20X BUY AO-1157
      OBJECTIVES....................... 10X,20X,45X,100X
      CAMERA ATTACHMENT................ YES (TRINOCULAR HEAD)
      CONDENSER........................ DARKFIELD
      FLUORESCENCE TECHNIQUE........... UV ILLUMINATOR 50 W HG VAPOR
                                        FILTER TURRET WITH 3 FILTERS
                                        AND OTHER ACCESSORIES
      POLARIZER........................ OBTAIN AO 1114B

425000 RECORDER - VOICE (CORE)                                LS1006    11111
425000
425000 CAPABILITY OF RECORDING ORAL COMMENTS.
425000
425000    CHANNELS ...................... 4
425000    BANDWIDTH ..................... 50 TO 20000 HZ
425000
   SONY CORP                   #TC110                 $130          112
      RECORDING TIME .................. UP TO 90 MIN
      RECORDING MEDIA...................MONAURAL CASSETTES,DUAL TRACK
      VOICE INPUT ..................... MICROPHONE OR AUXILLARY INPUT

   LEACH CORPORATION           #LEM RECORDER                        121
       RECORDING TIME ................. 10 HRS.
       FUNCTION ....................... VOICE RECORD
       TAPE CAPACITY .................. 450FT
       TAPE WIDTH ..................... 0.25 IN.
       TRACKS ......................... 4
       CHANNELS ....................... 1
       FREQ.RESPONSE .................. 300HZ TO 3.2KHZ AUDIO
       SIGNAL/NOISE RATIO ............. 35DB

507900 MICRODISECTION TOOL KIT                                LS998     11111
507900
507900    STANDARD MEDICAL MICRODISSECTION KIT
507900
274100 MICROTOME (CORE)                                       LS021     11111
274100
274100 CAPABILITY TO THINLY SLICE EXPERIMENT SPECIMEN.
274100
274100    SECTIONING .................... 1 TO 50 MICRONS
274100
   AMERICAN OPTICAL            #820                   $1254         111
      SECTION THICKNESS.................1 TO 50 MICRONS
      INPUT SPECIMEN BLOCK SIZE.........32 X 27 MM


   REICHERT                    #OM-12                 $5868         111
      THICKNESS RANGE.................. 1 TO 150 MICRONS
      STEPS............................ 0.2 MICRONS

   LEITZ                       #1212-MINOT ROTARY     $1430         111
      THICKNESS RANGE.................. 1 TO 25 MICRONS
      STEPS............................ 1 TO 12 MICRONS
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108600 CRYOSTAT (CORE)                                        LS022    11111
108600
108600 CAPABILITY OF STORING QUANTITIES OF CRYOGENIC LIQUID
108600
108600     QUANTITY ...................... 5 GALLONS (0.0019 CU M)
108600     TEMPERATURE ................... -319 F    (-195 C)
108600
    CRYOGENIC ASSOCIATES          #IR-90              $1000
        CAPACITY.........................0.6L LIQ. N2
        HOLDING TIME.....................24 HOURS
        DIMENSIONS.......................4.25IN DIAM, 8.5IN LONG
        WEIGHT...........................1.5LB(EMPTY),2.5LB(FULL)

    CRYOGENIC ASSOCIATES INC      #SD-15              $2852          112
        DEWAR DIA. ...................... 17 IN.
        LIQUID HELIUM CAP. .............. 101 LITERS
        LIQUID NITROGEN CAP. ............ 26.5 LITERS

    UNION CARBIDE CORP (LINDE)    #LR-21%0210-0C001    $225          111
        CAPACITY......................... 20 LITERS
        HEIGHT........................... 23 INCHES
        DIAMETER......................... 15-3/16 INCHES
        WEIGHT EMPTY..................... 23 LBS
               FULL...................... 59 LBS
        EVAPORATION RATE................. .22 LITER/DAY
        MAX HOLDING TIME................. 90 DAYS

    UNION CARBIDE (LINDE DIV.)    #0304-CC52(PART NO)  $1150         111
        CAPACITY LIQ HE.................. 30 LITERS
        EVAP RATE/DAY ................... .8%
        DIMENSIONS ...................... 44X18.75 INCHES
        WEIGHT .......................... 83 LB(MT) 91.4LB(FULL)

507900 VETERNARY MEDICAL KIT (CORE)                           LS997    11111
507900
507900 INCLUDES OTOSCOPE/OPTHALMOSCOPE, REFLEX HAMMER, HEMOGLOBINOMETER,
507900 TOURNIQUET, SYRINGES, NEEDLES, SCALPELS, HEMOSTATS, TWEEZERS, AND
507900 OTHER STANDARD ITEMS.
507900
186000 OVEN                                                   LS027    21111
186000
186000 CAPABILITY TO HEAT, MAINTAIN CONSTANT TEMPERATURE, AND DRY TEST
186000 EQUIPMENT, LIQUIDS AND TEST SPECIMEN.
186000
186000     TEMPERATURE RANGE ............ 32 TO 450 F (0 TO 233 C)
186000     CAPACITY ..................... 1 CU FT (0.03 CU M)
186000
    TENNY ENGINEERING INC         #BLT TO SPEC                       115
        PRESSURE ........................ VACUUM TO 1000 PSIG
        TEMPERATURE ..................... -100 TO 600 F

    FREAS  PRECISION              #605A               $725           111
        TEMPERATURE(MAX) ................ 660F(350C)
        POWER ........................... 3100W
        VOLUME .......................... 1.35CU.FT(0.04CU.M.)
        MOUNT ........................... BENCH

    NAPCO                         #620                $495           111
        TEMPERATURE(MAX) ................ 390F(200C)
        MOUNT ........................... BENCH
        VOLUME .......................... 3.8CU.FT.10.1CU.M)

    BLUE M                        #POM-143-A-1        $665           111
        TEMPERATURE(MAX) ................ 450F(230C)
        MOUNT............................ BENCH

    THELCO                        #18                 $395           111
        TEMPERATURE(MAX)................. 440F(225C)
        POWER............................ 1050W
        MOUNT............................ BENCH
        VOLUME........................... 1.35CU.FT(0.04CU.M)

507900 HISTOLOGY KIT/SLIDE CABINET (CORE)                     LS996    11111
507900
507900 STANDARD KIT CONTAINING PROBES, KNIVES, NEEDLES, SYRINGES, COVER
507900 SLIPS, LADLES PLUS OTHER NORMALLY INCLUDED ITEMS.
507900
486500 CONSTANT TEMPERATURE BLOCK (CORE)                      LS1015   21111
486500
486500 HEAT SINK MAINTAINING A CONSTANT TEMPERATURE FOR TEST TUBES AND
486500 VIALS.
486500
486500     TEMPERATURE .................. 248+/-1.0 F (120+/-0.5 C)
486500
    DCW DIAGNOSTICS               #12/IA              $100           111
        CONFIGURATION ................... LOOSE EQUIP
        TEMPERATURE RANGE ............... AMBIENT TO 140C
        CONTROL .........................  +/- 0.5 C

464600 SPECTROPHOTOMETER - IR (CORE)                          LS032    11111
464600
464600 PERFORM SPECTROPHOTOMETER ANALYSIS OF LIFE SCIENCES SPECIMEN IN
464600 THE INFRARED RANGE .
464600
464600     SPECTRAL RANGE ............... 2.5 TO 12 MICRONS
464600     RESOLUTION ................... 0.1 PERCENT OF WAVELENGTH
464600     SCAN TIME .................... 5 SEC TO 50 HOUR
464600     SAMPLE TEMPERATURE ........... AMBIENT TO 482 F (250 C)
464600
    PERKIN ELMER INSTRUMENT DIV.  #323                $15200         111
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        WAVELENGTH RANGE ................ 185 TO 2500 NANOMETERS
        MODES ........................... X-Y RECORDER
                                          AUTOMATIC REPETATIVE SCAN

     G K TURNER ASSOCIATES        #350             $1609         111
        WAVELENGTH RANGE ................ 210NM TO 1000NM
        ACCESSORIES ..................... 330-030 IR ACCESSORY
                                          330-040 UV ACCESSORY
        OPTICS .......................... REFLECTION TYPE
        WAVELENGTH ACCURACY ............. +/- 2NM
        WAVELENGTH READOUT .............. DIGITAL IN NM
        PHOTOMETRIC METER ACCURACY ...... +/-0.5%

     PERKIN-ELMER                 #221             $18050        111
        SPECTRAL RANGE................... 1.0 TO 15.5 MICRONS
        RESOLUTION....................... .02 MICRONS AT 12 MICRONS
        ACCURACY......................... +/- .5 PER CENT
        ORDINATE EXPANSION............... .25X TO 40X
        ABSCISSA EXPANSION............... .25X TO 40X
        POWER............................ 105-125V 60 HZ 500W

     BECKMAN INSTRUMENTS          #IR-9            $23000        111
        SPECTRAL RANGE .................. 2.5 TO 25 MICRONS
        RESOLUTION ...................... .25CM-1 AT 923CM-1
        SCAN TIME ....................... 5MIN TO 18 DAYS
        ACCURACY......................... .2% WITH CALIBRATION
        HOT AND COLD SAMPLES ............ YES

     BECKMAN INSTRUMENTS          #6800 IR-4       $19740        111
        SPECTRAL RANGE .................. 1 TO 16 MICRONS
        RESOLUTION ...................... .01MICRON AT 10MICRONS
        SCAN TIME ....................... 3MIN TO 24 HRS
        ACCURACY ........................ .015MICRON FROM 3.3-16MICRONS
        HOT AND COLD SAMPLES ............ YES

435000 GAS ANALYZER, AUTOMATIC                             LS993   11111
435000
435000 DETERMINE THE PARTIAL PRESSURES OF OXYGEN AND CARBON DIOXIDE
435000 DISSOLVED IN BLOOD SAMPLES AND TO DETERMINE THE HYDROGEN ION
435000 CONCENTRATION
435000
435000    (REQUIREMENTS UNSPECIFIED. COMMERCIAL UNIT USED AS MODEL)
435000    PH..............................6.000 TO 8.000
435000    CO2 PARTIAL PRESSURE............0 TO 200MM HG
435000    O2 PARTIAL PRESSURE.............0 TO 2000MM HG
435000    ACCURACY:
435000         PH.........................+/-0.003
435000         CO2 PARTIAL PRESSURE.......+/-0.5 MM HG
435000         O2 PARTIAL PRESSURE........+/-1MM HG AT 200 MM HG O2
435000                                    +/-10MM HG AT 2000 MM HG O2
435000
     INSTRUMENTATION LABORATORY   #IL 313          $6990
        PH .............................. 6.0 TO 8.0
        PCO2 ............................ 0 TO 200 MMHG
        PO2 ............................. 0 TO 2000 MMHG
        AUTOMATICALLY PROGRAMMED ........ YES
        SAMPLE TIME ..................... 45 SEC
        PRECISION PH .................... +/-.003
                  PCO2 .................. +/-1MMHG
                   PO2 .................. +/-10MMHG
        SAMPLE SIZE.......................0.4ML (AUTOMATED)
        POWER ........................... 115V 50/60 HZ

521700 URINE ANALYZER - AUTOMATIC (CORE)                   LS994   11111
521700
521700 CAPABILITY TO AUTOMATICALLY PERFORM URINE ANALYSES.

521700
459605 MASS SPECTROMETER                                   LS994   11111
459605
459605 PROVIDE ANALYSIS OF UNKNOWN IONIZED GAS BY ATOMIC MASS NUMBER.
459605
459605     MASS RANGE......................1 TO 400AMU
459605     SCANNING RANGE..................VARIABLE
459605     VARIABLE SCANNING RATE..........50 MILLISECOND TO 600 SEC/SCAN
459605     MAX OPERATING PRESSURE..........1E-4TORR
459605     SELECTABLE CENTER MASS
459605     SELECTABLE SCANNING WIDTH
459605
     GRANVILLE-PHILLIPS CO        #400             $6975         112
        CONFIGURATION ................... BENCH EQUIP
        MASS RANGE ...................... 1 TO 400 AMU
        SCANNING RATE ................... 50 MSEC TO 600 SEC (VARIABLE)
        MAX OPERATING PRESSURE .......... 1E-4 TORR

374000 PH METER                                            LS1016  11111
374000
374000 METER MEASURES HYDROGEN ION CONCENTRATION OF SOLUTIONS
374000
374000     PH RANGE........................0 - 14
374000     MEASUREMENT ACCURACY............0.02PH
374000
     BECKMAN INSTRUMENTS          #PHASAR 1        $570
        PH RANGE......................... 0.00 TO 14.00
        REPEATABILITY.................... +/- 1 MV, +/- 0.01 PH
        AUTO TEMP COMPENSATION........... 0 TO 100 C
        DIMENSIONS ...................... 5-3/4HX12-3/4WX8-5/8D(INCH)
        WEIGHT .......................... 5 LB
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    BECKMAN INSTRUMENTS          #76                     $445         111
         CONFIGURATION ..................... LOOSE EQUIPMENT
         PH RANGE .......................... 0 TO 14
         PH MEASUREMENT ACCURACY ........... +/- 0.02 PH
         PH MEASUREMENT REPEATABILITY ...... TO +/- 0.003 PH
         MILLIVOLT RANGE ................... 0 TO 1400 MV
         MV MEASUREMENT ACCURACY ........... +/- 2MV
         MV MEASUREMENT REPEATABILITY ...... TO +/- 0.3 MV

    BECKMAN INSTRUMENTS          #123502                  $535         111
         RANGE.............................. 0 TO 14PH
         ACCURACY .......................... 0.01
         RECORDER OUTPUT ................... 1 TO 100 MV
         REPEATABILITY ..................... +/-0.01PH
         DIMENSIONS ........................ 5.75X12.75X8.62 INCHES
         WEIGHT ............................ 5 LBS
         TEMP COMPENSATION ................. 0 TO 100 C

    BECKMAN INSTRUMENTS          #76009                   $695         111
         RANGE ............................. 0 TO 14(ANY 1.4PH(EXPANDED)
         ACCURACY .......................... +/-.05PH+/-.007 (EXPANDED SCALE
         REPEATABILITY ..................... +/-.02PH +/-.002(EXPANDED SCALE
         TEMP COMPENSATION ................. 0 TO 100 C
         RECORDER OUTPUT ................... 0 TO 200 MV
         POWER ............................. 115/230V 50/60HZ 15W
         DIMENSIONS ........................ 11X11X9 INCHES
         WEIGHT ............................ 9LBS (4KG)

201000 ULTRASONIC CLEANER (CORE)                                LS047   11111
201000
201000 HIGH FREQUENCY ENERGY FOR CLEANING EXPERIMENT AND MAINTENANCE
201000 EQUIPMENT.
201000
201000     OPERATING FREQUENCY ........... 20000 HZ
201000     CAPACITY ...................... 1 CU FT
201000
    BRANSON                      #2                       $55          111
         TANK SIZE ......................... 3.5X3.5X2.5 IN(9X9X6.5 CM)
         CAPACITY........................... 1 QUART

    BRANSON                      #32                      $225         111
         TANK SIZE...........................6X11X6IN(15.2X28X15.2CM)
         CAPACITY............................1 1/2 GALLON

    BAUSCH AND LOMB INC          #BALSONIC II             $500         111
         CAPACITY .......................... 1 GALLON
         TANK DIMS ......................... 7.25X9.125X3.875IN**3

    BECKMAN INSTRUMENTS(SC.ESS.DV)#92-H                   $885         111
         FREQUENCY.......................... 50000 HZ
         CAPACITY .......................... 1 CU FT
         HEATING ........................... UP TO 60 C

532000 VOLT OHM METER                                           LS1012  11111
532000
532000 PORTABLE RELIABLE MULTI-FUNCTION METER FOR GENERAL PURPOSE EXPER-
532000 IMENTAL WORK AND TROUBLE SHOOTING.
532000
532000     DC VOLTS ...................... 100 MV TO 10 KV
532000     DC CURRENT .................... 1 MA TO 10 AMPS
532000     AC VOLTS ...................... 10 MV TO 300 VOLTS
532000     AC CURRENT .................... 1 MA TO 1 AMP
532000     OHMMETER ...................... 10 OHMS TO 10 MOHMS
532000
    KLS                          #SERIES X-1              $4000
         ACCURACY .......................... +/-0.0008%FS
         FUNCTIONS ......................... DC VOLTS, AC VOLTS, MILLIVOLTS,
                                             K OHMS AND RATIO
         COMMON MODE REJECTION ............. >136DB

    ROHDE AND SCHWARZ            #UVV (110.4716.02)  $900              111
         VOLTAGE RANGE ..................... 0.1 MV TO 1000 V (DC OR AC)
         FREQUENCY RANGE ................... 0 TO 100 KHZ
         CURRENT RANGE ..................... 0.1 NA TO 1000 MA

    HEWLETT PACKARD              #427A/428B/456A          $1150        112
         CONFIGURATION ..................... LOOSE EQUIP
         VOLTAGE RANGE ..................... 100 MV TO 1000 V (DC VOLTAGE)
                                             10 MV TO 300 V (AC VOLTAGE)
         OHMMETER .......................... 10 OHM TO 10 M OHM
         CURRENT RANGE ..................... 1 MA TO 1 A (DC)
                                             1 MA TO 1 A RMS (AC)

    SIMPSON                      #269-3                   $98          111
         CONFIGURATION...................... LOOSE EQUIPMENT
         VOLTAGE RANGE...................... AC-3,8,40,160,400,800VOLTS
                                             DC-1.6,8,40,160,400,800,1600,
                                             4000VOLTS
         OHMMETER........................... 2K,20K,200K,2MEG,20MEG,AND
                                             200MEGOHMS
         CURRENT RANGE...................... 16,160MICROAMPERES
                                             1.6,16,160MILLIAMPERES
                                             1.6,8 AMPERES
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    JOHN FLUKE MFG CO INC          #8125A              $1945          111
        VOLTAGE RANGE ................... +/- 1 V TO +/- 1000 VDC
                                          1 V TO 1000 VAC
        RESOLUTION ...................... +/- 0.01%
        FREQUENCY RANGE ................. DC, 30 HZ TO 20 KHZ

    JOHN FLUKE MFG CO INC          #8425A-01           $5995          311
        VOLTAGE RANGE ................... +/- 0.1 TO +/- 1000 VDC
                                          1 TO 1000 VAC
        RESOLUTION ...................... 0.001%
        FREQUENCY RANGE ................. DC, 10 HZ TO 100 KHZ

181000 SIGNAL GENERATOR                                       LS052    11111
181000
181000 ACCURATELY REPRODUCE SELECTED FREQUENCIES AS REFERENCES FOR PUR-
181000 POSES OF MAINTENANCE AND REPAIR.
181000
181000     BANDWIDTH ..................... DC TO 20 KHZ
181000     OUTPUT VOLTAGE ................ 3 V TO 0.1 MV
181000
    INTERSTATE ELECTRONICS CORP    #F32                $345           111
        FREQUENCY RANGE ................. 0.03 HZ TO 3 MHZ
        ACCURACY ........................ +/- 2%
        AMPLITUDE ....................... 60 DB ATTENUATION, 20 V P-P
                                          INTO OPEN CIRCUIT
        OFFSET .......................... +/- 10 V (VARIABLE)

    EXACT ELECTRONIC INC           #122                $395           111
        BANDWIDTH ....................... 0.1 HZ TO 3 MHZ
        FREQUENCY STABILITY ............. 0.04%/10 MIN, 0.2%/24 HOURS
        OUTPUT .......................... 80 DB ATTENUATION IN 10 DB STEP
                                          >10 V P-P INTO 50 OHMS
        DC OFFSET ....................... +/- 10 VOLTS

    KROHN-HITE                     #5300               $720
        WAVEFORMS........................ SINE, SQUARE, TRIANGLE, RAMPS,
                                          PULSES, LIN-LOG SWEEP,TRIGGERED
                                          AND BURST
        BANDWIDTH........................ 0.002HZ TO 3MHZ
        MOUNT............................ RACK
        FREQUENCY STABILITY.............. 0.05% IN 10 MIN
        SIZE............................. 19X5-1/4X15-1/2
        WIEGHT........................... 16LB (8KG)


    ROHDE AND SCHWARZ              #SSN (204.8014.XX)  $5380          111
        FREQUENCY RANGE ................. 0.01 HZ - 120 KHZ
        OUTPUT LEVEL .................... 7.75 MV - 6 V

    JOHN FLUKE MFG CO INC          #645A-1568          $13,950
        FREQUENCY RANGE ................. DC TO 50 MHZ
        INCREMENTS ...................... 0.01 HZ
        SPURIOUS OUTPUTS ................ > 100 DB (NON-HARMONICS)
                                          > 30 DB (HARMONICS)
        SIGNAL-TO-PHASE NOISE RATIO .... > 66 DB
        FREQUENCY STABILITY ............. 2E-9/24 HOURS AVAILABLE

    JOHN FLUKE MFG CO INC          #633A               $6865          111
        CONFIGURATION ................... RACK MOUNTED
        FREQUENCY RANGE ................. DC TO 11 MHZ
        INCREMENTS ...................... 10 HZ
        ACCURACY ........................ +/- 2% OF RANGE

    INCRE-DATA CORP.               #128                $695           112
        RANGE ........................... 0.1 TO 3MHZ, 20 HZ TO 20 KHZ
        STABILITY ....................... 0.05 % OF SETTING FOR 10 MIN.
                                          0.25 % OF SETTING FOR 24 HRS.
        ACCURACY ........................ +/- 2 % OF FS
        RAMP GENERATOR .................. 100 S TO 10 MICROSEC
        WAVE FORMS ...................... SINE, SQUARE, TRIANGLE, RAMP,
                                          PULSE, SYNC
    WAVETEK                        #130                $395           111
        FREQUENCY RANGE ................. 0.2 HZ TO 2 MHZ
        OUTPUT .......................... 40 DB ATTENUATION (VARIABLE)
                                          10 V P-P INTO 50 OHMS
        DC OFFSET ....................... +/- 5 VOLTS
        RESOLUTION ...................... +/- 2% FS (1 HZ TO 2 MHZ)
        STABILITY ....................... +/- 0.05%/10 MIN, +/- 0.25%/24
                                          HOURS

399500 PLETHYSMOGRAPH, LIMB(INCLUDING COUPLER)                LS1010   11111
399500
399500 MEASURE CHANGES IN BLOOD VOLUME AND VASCULAR RESPONCES
399500
399500     MEASUREMENT RANGE...............HIGH RANGE-15 TO 500 OHMS
399500                                    LOW RANGE-1.5 TO 50 OHMS
399500
    HONEYWELL INC                  #EIP-4                             111
        TYPE ............................ IMPEDANCE PLETHYSMOGRAPH
001000 ACCELEROMETER - SPECIMEN MOVEMENT                      LS901   121111
001000
001000 ORGANISM CONTAINER ACTIVITY AND ACTIVITY LEVEL MONITER.
001000
001000     ACCURACY ...................... +/- 0.0004 G
001000     FREQUENCY RESPONSE ............ 0 TO 100 HZ
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001000
    ENDEVCO-INERTIAL INSTRUMENTS  #QA-116-16              $650         111
        TYPE ........................... ULTR-SENSITIVE, LINEAR
        RANGE .......................... +/- 1G
        SENSITIVITY .................... 1 VOLT/G
        FREQUENCY REXPONSE ............. DC TO 300 HZ
        RESOLUTION ..................... 1E-6 G
        THRESHOLD ...................... 1E-6 G

003210 AUDIOMETER                                              LS902   11111
003210
003210 FREQUENCY SOURCE ADJUST IN BOTH FREQUENCY AND AMPLITUDE FOR
003210 EARPHONES OR BONE VIBRATORS
003210
003210     FREQUENCY................125 TO 8000 ADJUSTIBLE IN OCTAVES
003210     ATTENUATOR...............CONTINUOUSLY ADJUSTIBLE IN 1DB STEPS
003210
    LAFAYETTE INSTRUMENT CO        #3120-AC            $440         112
        CONFIGURATION .................. BENCH EQUIP
        FREQUENCY ...................... OCTIVE FREQUENCIES  125 TO 8000
                                         HZ, INTERMEDIATE FREQUENCIES
                                         750 TO 6000 HZ
        ATTENUATOR ..................... 1 OR 5 DB STEPS

462500 ANALYZER - ATOMIC ABSORPTION SPECTROPHOTOMETER          LS903   11111
462500
462500 QUANTITATIVE DETERMINATION OF METALLIC AND SEMIMETALIC ELEMENTS
462500 IN SOLUTIONS AND INDICATING CONCENTRATION.
462500
462500     WAVELENGTH RANGE ............ 200 TO 800 NM
462500     MODES OF OPERATION .......... ATOMIC ABSORPTION, FLAME
462500                                   EMISSION, UV-VISIBLE SPECTRO-
462500                                   PHOTOMETRY
462500     COUNTER ACCURACY ............ +/- 0.4 NANOMETERS
462500
    BECKMAN INSTRUMENTS            #24                 $2760
        OPERATING RANGE ................ 340 TO 700
        WAVELENGTH RANGE................ 190 TO 1000
        PRESENTATION ................... DIGITAL COUNTER, 0.2
                                         NM INCREMENTS
        ACCURACY ....................... +/- 0.5 NM
        REPEATABILITY .................. +/- 0.2 NM
        DIMENSIONS ..................... 24X16X14 INCHES
        WEIGHT ......................... 70 LBS

    BAUSCH AND LOMB                #AC2-20             $6280        111
        CONFIGURATION .................. MODULAR/BENCH
        MODES OF OPERATION ............. ATOMIC ABSORPTION, FLAME
                                         EMISSION, UV-VISIBLE SPECTRO-
                                         PHOTOMETRY
        WAVELENGTH RANGE ............... 190 TO 800 NM
        WAVELENGTH READOUT ............. DIGITAL COUNTER
        WAVELENGTH COUNTER ACCURACY .... +/- 0.4 NM
        WAVELENGTH SETTABILITY ......... > +/- 0.001 NM

    E.E.L. (AUTHUR H THOMAS CO)    #140                $3275        111
        CONFIGURATION .................. BENCH/LOOSE EQUIP
        MODE OF OPERATION .............. ATOMIC ABSORPTION
        WAVELENGTH RANGE ............... 200 TO 800 NM
        ACCURACY ....................... +/- 1%

    BECKMAN                        #979                $5950
        CONFIGURATION .................. BENCH/LOOSE EQUIP
        TYPE ........................... ATOMIC ABSORPTION WITH GRATING
                                         MONOCHROMATOR
        WAVELENGTH RANGE ............... 190 TO 770 NM
        ACCURACYR....................... > +/- 0.5 NM
        RESOLUTION ..................... 0.2 NM

042000 CELL COUNTER - BLOOD                                    LS907   11111
042000
042000 MEASURE BLOOD CELL PROPERTIES OF BLOOD SAMPLES. ESSENTIALLY A
042000 COULTER COUNTER
042000
042000     PARAMETERS MEASURED ..........HEMOGLOBIN,HEMATOCRIT,RED BLOOD
042000                                    CELL COUNT,WHITE BLOOD CELL
042000                                    COUNT,MEAN CELL VOLUME,MEAN
042000                                    CELL HEMOGLOBIN AND MEAN CELL
042000                                    HEMOGLOBIN CONCENTRATION
042000     REPRODUCIBILITY...............+/-1%
042000
    COULTER ELECTRONICS            #FN                 $5000
        PARTICLE SIZE ..................0.003 TO 24 MICRONS
        COUNTING RATE ..................0.040 ML/SEC
        DIMENSIONS......................49CM H X 35 CM W X 44 CM D
        WEIGHT .........................54LB (24.5KG)

    COULTER ELECTRONICS INC        #S                  $50000
        PARAMETERS ..................... HEMOGLOBIN, HEMATOCRIT, RED
                                         BLOOD CELL COUNT, WHITE BLOOD
                                         MEAN CELL HEMOGLOBIN, AND MEAN
                                         CELL COUNT, MEAN CELL VOLUME,
                                         CELL HEMOGLOBIN CONCENTRATION
        TYPE ........................... AUTOMATIC

    COULTER ELECTRONICS INC        #281-6              $10000       112
        PARAMETERS ..................... HEMOGLOBIN, HEMATOCRIT, RED
                                         BLOOD CELL COUNT, WHITE BLOOD
                                         CELL COUNT, MEAN CELL VOLUME,
                                         MEAN CELL HEMOGLOBIN, AND MEAN
                                         CELL HEMOGLOBIN CONCENTRATION
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         TYPE ............................. MANUAL

096000 BACTERIAL COLONY COUNTER                              LS908    11111
096000
096000 MANUAL COUNT OF BACTERIAL COLONIES. UNIT IS STANDARD TYPE
096000
    AMERICAN OPTICAL CORP          #3330                 $115          112
         REGISTER.......................... MODEL AO 3348 USED TO OBTAIN
                                            CUMULATIVE RECORDING OF COUNTS
         TYPE ............................. QUEBEC COLONY COUNTER, DARK-
                                            FIELD ILLUMINATION APH
         DIMENSIONS........................ 10X11X10 INCHES

104160 DIGITAL PLOTTER, PRINTER                              LS909    11111
104160
101340 KEYBOARD                                              LS910    11111
101340
101340 TYPEWRITER TYPE KEYBOARD USED FOR PROVIDING INSTRUCTIONS FOR THE
101340 COMPUTER
101340
    TEKTRONIX                      #4601                 $3750         111
         DISPLAY .......................... ALPHANUMERIC AND GRAPHIC
         COPY SIZE ........................ VARIABLE BETWEEN 8.5X6 IN AND
                                            8.5X14 IN
         COPY TIME ........................ 18 SEC (FIRST COPY)
         RESOLUTION ....................... ACTUAL SIZE OF 4000 CHARACTER
                                            DISPLAY, BASED ON 90X70 MIL
                                            MATRIX

    VARIAN DATA MACHINES           #ASR 33 & ASR 35                    111
         SPEED ............................ 10 CHARACTERS/SEC.
         PAPER ............................ CONTINUOUS ROLL 8.5IN WIDE
         TYPING LINE ...................... 85 CHARACTERS

620060 ELECTROPHYSIOLOGY BACKPACK                            LS912    11235
620060
620060 BACKPACK CONTAINS THE NECESSARY ELECTRONICS FOR SENSING AND
620060 TRANSMITTING MAN'S PHYSIOLOGICAL DATA SUCH AS ECG, EEG, EMG,
620090 ECG, ETC. INCLUDES SENSORS, SIGNAL CONDITIONERS, MULTIPLEXERS,
620060 A/D CONVERTERS AND TRANSMITTERS
620060
    HEWLETT PACKARD                #78100A               $600          112

618090 ELECTROPHYSIOLOGY RECEIVER                            LS913    11111
618090
618090 PROVIDE SPECIAL RECEPTION OF CARDIOVASCULAR AND NEURAL ELECTRO-
618090 PHYSIOLOGICAL EVENTS VIA BIOTELEMETRY SYSTEMS
618090
618090    SIGNAL TYPES RECEIVED.........ELECTROENCEPHALOGRAM
618090                         .........ELECTROCARDIOGRAM
618090                         .........VECTORCARDIOGRAPHY
618090                         .........BALISTOCARDIOGRAPHY
618090                         .........IMPEDANCE CARDIOGRAPHY
618090                         .........PHONOCARDIOGRAPHY
618090
043000 BLOOD CLOT FIBROMETER                                 LS915    11111
043000
043000 PROVIDE AUTOMATIC MEASUREMENT OF PLASMA COAGULATION TIME
043000
043000    ACCURACY.......................+/-0.1SECOND
043000
    B-D-L                          #84180-1,-2,-3,-5,-6  $974          111
         CONFIGURATION .................... MODULAR EQUIP
         COAGULATION TIME ACCURACY ........ +/- 0.1 SEC
         THERMAL PREP-BLOCK ............... HOLDS UP TO 20 FIBROTUBE DIS-
                                            POSABLE REACTION CUPS, AND UP
                                            TO TEN 12 MM TEST TUBES. PRE-
                                            HEATS AND MAINTAINS PLASMA AND
                                            REAGENTS AT 37 C
         AUTOMATIC PIPET .................. DELIVERS MEASURED 0.1 OR 0.2 ML
                                            VOLUMES OF PLASMA OR REAGENT

108600 FREEZER, CRYOGENIC                                    LS916    11111
108600
108600 PROVIDE A MEANS FOR FREEZING AND STORING BIOLOGICAL SPECIMENS
108600
108600    STORAGE CAPACITY...............115 CU.IN. (1.89LITERS)
108600    OPERATING TEMPERATURE..........-320F(78K)
108600    MIN CRYOGEN HOLDING TIME.......3 WEEKS BETWEEN REFILLS
108600
    CRYOGENIC ASSOCIATES           #IR-50                $1000
         CAPACITY..........................0.6L LIQ. N2
         HOLDING TIME......................24 HOURS
         DIMENSIONS........................4.25IN DIAM, 6.5IN LONG
         WEIGHT............................1.5LB(EMPTY),2.5LB(FULL)

    UNION CARBIDE CORP/LINDE DIV  #LR-10A-6              $2500         112
         CONFIGURATION .................... LOOSE EQUIP
         LIQUID NITROGEN CAPACITY ......... 10.4 LITERS
         STORAGE TEMPERATURE .............. -320 F
         CAPACITY ......................... 6 CANISTERS, 115 CU. IN.
         LIQUID NITROGEN CONSUMPTION ...... 0.34 L/DAY (W/O CANISTERS)
                                            0.36 L/DAY (W/CANISTERS)

207500 HEMATOCRIT, ELECTRONIC                                LS917    11111
207500
207500 AUTOMATICALLY DETERMINE THE PERCENT HEMATOCRIT IN BLOOD.
       RAPID % READOUT AND TEMPERATURE COMPENSATOR REQUIRED
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207500
    YELLOW SPRINGS INSTRUMENT      #30                    $275          112
         CONFIGURATION .................... LOOSE EQUIP
         ANALYSIS TIME .................... < 30 SEC
         PIPET ............................ 0.02 ML WHOLE OR HEPARINIZED
                                            BLOOD

308500 DOSIMETER, RADIATION DETECTOR                         LS918   11111
308500
308500 PORTABLE DEVICE WHICH WILL ALERT USER TO RADIATION LEVELS IN
308500 EXCESS OF A PREDETERMINED LEVEL AND TO PROVIDE A DIRECT READOUT
308500 OF THE TOTAL CUMULATIVE RADIATION DOSE.
308500
308500     RATE MEASUREMENT RANGE ........ 0 TO 0.1 MR/HR
308500                                     0 TO 50 R/HR
308500     ADJUSTABLE RADIATION ALARM ... 0.05 MR/HR TO 50 R/HR
308500     CUMULATIVE DOSAGE RANGES ...... 0 TO 200 MR
308500                                     0 TO 500 R
308500     ACCURACY (X- & GAMMA RAY) .... +/- 10 %
308500
    KAHL SCIENTIFIC INSTRUMENT     #FH 402                $130          112
         CONFIGURATION .................... PORTABLE, FULLY TRANSISTORIZED
         RATE MEASUREMENT RANGES .......... 0 TO 50 MR/HR
         ACCURACY ......................... +/- 15% (FOR GAMMA)
         TEMPERATURE RANGE ................ 15 TO 130 F

305000 RADIATION DETECTOR                                    LS919   11111
305000
305000 ACCURATE MEASUREMENT OF EITHER ALPHA, BETA, GAMMA, X-RAY OR
305000 NEUTRON RADIATION AS IT IS APPLIED TO A BIOLOGICAL SPECIMEN.
305000
305000     RATE RANGES ...................... 0 TO 0.1 MR/HR
305000                                       0 TO 1000 R/HR
305000     CALIBRATED READOUTS ........... COUNTS/SEC, /MIN, AND TOTAL
305000
    HEWLETT PACKARD                #5880A/5583A/   $1150/$650          112
                                   5590A/5554      $1875/$360
                                   /5582A          $750
         CONFIGURATION .................... MULTI-UNIT BENCH EQUIP
         RADIATION DETECTED ............... ALPHA, BETA, X-RAY, GAMMA OR
                                            NEUTRON
         RATE MEASUREMENT RANGE ........... 0 TO 1000 R/HR

315500 ISOTOPE SOURCE -SELF CONTAINED                        LS920   11111
315500
315500 RADIATION STRESS SOURCE USED IN CONDUCTING RED BLOOD CELL
315500 SURVIVAL STUDIES.  TYPICAL ASSORTMENT - NITROGEN 15 COMPOUNDS,
315500 RADIOLABELED SUBCELLULAR PRODUCTS (RIBOSOMES), RADIOLABELED POLY-
315500 NUCLEOTIDES OR TITRATED THYMIDINE.
315500
315500     RADIATION LEVEL ................ 1 TO 100 MICROCURIE
315500
    MILES LABORATORIES              ASSORTMENT      $1-5K EA           111
         TYPES ..........................CARBON-13 LABELED COMPOUNDS,
                                         NITROGEN-15 LABLED COMPOUNDS,
                                         TRITIUM AND CARBON-14 LABELED
                                         RADIOACTIVE ISOTOPIC COMPOUNDS,
                                         HOMOPOLYMERS, RADIOLABLED POLY-
                                         NUCLEOTIDE DUPLEXES

618090 BIOTELEMETRY RECEIVER - COMPACT CAGE MODULE           LS921  121113
618090
618090 MICROBACKPACKS FOR SMALL VERTEBRATE ACQUIRING AND TRANSMITTING
618090 BIO DATA.
618090
    HEWLETT PACKARD                #78101A                $800          112
         CONFIGURATION .................... MICROBACKPACK
         ANTENNA .......................... LOW PROFILE MONOPOLE

603003 SIGNAL CONDITIONER                                    LS922   11111
603003
603003 ELECTRICAL SIGNAL TRANSFORMATION BETWEEN ANY NUMBER OF TRANS-
603003 DUCERS AND MULTIPLEXER/ANALOG TO DIGITAL CONVERTER
603003
603003     COMPUTER INPUT ................. +/- 10 VOLTS
603003
    HEWLETT PACKARD                #8807A WITH OPTION     $775
                                   001
         CONFIGURATION .................... PLUG IN UNIT FOR OSCILLOGRAPHIC
                                            RECORDER
         FREQUENCY RANGE .................. 50 HZ TO 100 KHZ
         INPUT RANGES ..................... 0.02, 0.05, 0.1, 0.2, 0.5, 1,
                                            2, 5, 10 V RMS/DIV
         ACCURACY ......................... +/- 2%


    TENNELEC                       #TC133                 $295          111
         FET PREAMPLIFIER
         CHARGE SENSITIVITY................ 10E12 VOLTS/COULOMB
         INPUT............................. NEGATIVE INPUT PULSE POLARITY
                                            WITH INPUT CAPACITANCE >2000PF
         OUTPUT............................ POSITIVE OUTPUT PULSE POLARITY
                                           WITH OUTPUT IMPEDANCE 50 OHM
         STABILITY......................... 0.5%/V

    HEWLETT PACKARD                #461A                  $380          111
         FREQUENCY RANGE .................. 1 KHZ TO 150 MHZ
         FREQUENCY RESPONSE ............... +/- 1 DB INTO 50 OHM LOAD
         GAIN AT 500 KHZ .................. 40 DB +/- 0.5 DB OR 20 +/- 1 DB
         MAX INPUT ........................ 1 V RMS OR 2 V P-P PULSE
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TENNELEC                          #TC 202/203     $355/455
     GAIN.............................. 2.5 TO 3000X
     NON LINEARITY..................... LESS THAN 0.05%
     CONFIGURATION..................... NIM COMPATIBLE

ROHDE AND SCHWARZ                #ATN (100.0899.02)                 111
     FREQUENCY RANGE .................. 30 HZ TO 20 MHZ
     INPUT VOLTAGE .................... 0.25 - 25 VOLTS
     MAX POWER ........................ 50 WATTS

RESEARCH INC                     #812-11-17           $3200         111
     CAPACITY ......................... TO 32 PAIRS OF SIG WIRES (16GA)
     REFERENCE TEMP ................... HEAT SINK CONTROLLED TO +/- .08
                                        DEG C AT 65 DEG C
     AMBIENT TEMP ..................... 0 TO 49 DEG C
     LEAKAGE RESISTANCE ............... 1000 MEG OHM
     HEAT-UP TIME FROM 22 DEG C ....... 50 MINUTES
     SETTLING TIME .................... 8 MS TO FINAL VALUE

HONEYWELL                        #ACCUDATA 117        $1340         111
     MULTICHANNEL WIDEBAND AMPLIFIER
     CHANNELS.......................... 7
     MOUNT............................. BENCH

HONEYWELL                        #ACCUDATA 115        $5370         111
     HIGH VOLTAGE DC AMPLIFIER
     INPUT SIGNAL VOLTAGE.............. +/-50MV TO 1500V
     OUTPUT SIGNAL VOLTAGE............. UP TO 2000V
     CHANNELS.......................... 6

NEFF                             #122-222             $610          111
     GAIN..............................1 TO 2500
     COMMON MODE REJECTION............. 140DB
     DRIFT............................. 0.5MICROVOLT/DC
     STEP GAIN ACCURACY................ +/-0.01%
     SWITCH SELECTABLE FILTER
     BANDWIDTH......................... 100KHZ
     RACK/MODULE MOUNT

NEFF                             #126-621             $320          111
     AMPLIFIER MULTIPLEXER
     EMPLOYES FET SWITCH
     GAIN RANGE........................ 0.2 TO 2500
     COMMON MODE REJECTION............. 120DB
     OUTPUT............................ +/-10V AT 10 MILLIAMPERES

NEFF                             #127-102             $1150
     PROGRAMMABLE GAIN WITH SWITCH SELECTABLE OUTPUT FILTER
     GAIN STEPS........................ 1, 2, 5, 10, 20, 50, 100, 200,
                                        500,1000
     COMMON MODE REJECTION............. 140DB
     FET SWITCHING
     RACK/MODULE CONFIGURATION

TENNELEC                         #TC133               $295          111
     FET PREAMPLIFIER
     CHARGE SENSITIVITY................ 10E12 VOLTS/COULOMB
     INPUT............................. NEGATIVE INPUT PULSE POLARITY
                                        WITH INPUT CAPACITANCE >2000PF
     OUTPUT............................ POSITIVE OUTPUT PULSE POLARITY
                                       WITH OUTPUT IMPEDANCE 50 OHM
     STABILITY......................... 0.5%/V

STATHAM/V MUELLER AND CO         #SM1020/SM1011/      $3000         111
                                  SM1008/SM1006
     CONFIGURATION .................... RACK MOUNTED
     TYPES ............................ VENUS PRESSURE MODULE - DISPLAY
                                        METER ( 5 TO 30 MM HG)
                                        BRIDGE AMPLIFIER MODULE - SIX
                                        SENSITIVITY RANGES (0-1 MV FS,
                                        0-2 MV FS, 0-5 MV FS, 0-10 MV
                                        FS, 0-20 MV FS, 0-50 MV FS WITH
                                        7.5 V EXCITATION)
                                        ELECTRONIC THERMOMETER MODULE -
                                        (METER SCALES 93-107 F, 34-41C)

HONEYWELL                        #ACCUDATA 106        $400          111
     MILLIVOLT/THERMOCOUPLE CONTROL UNIT
     CONTAINS COLD JUNCTION COMPENSATION, SUPPRESSION, CALIBRATION,
     AND ATTENUATION
     MOUNTS............................ MODULE IN 7X19IN.RACK

HONEYWELL                        #ACCUDATA 120        $430          111
     DC AMPLIFIER
     FREQUENCY RESPONCE................ DC TO 100KHZ
     GAIN.............................. X10 TO X1000 IN EIGHT STEPS
     COMMON MODE REJECTION............. GREATER THAN 80DB
     INPUT IMPEDANCE................... OVER 10 MEGOHMS
     MOUNT............................. MODULE IN 7X19IN. RACK

HONEYWELL                        #ACCUDATA 122/123 $495/600         111
     DIFFERENTIAL WIDEBAND AMPLIFIER
     INPUT RANGE....................... +/-2MV TO 300VF.S.
     GAIN SETTINGS..................... 16
     FILTERING......................... SELECTABLE
     BANDWIDTH......................... DC TO 100KHZ
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OF POOR QUALITY

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    HONEYWELL                      #ACCUDATA 218-2        $885          111
         CAGE CONTROL/AMPLIFIER
         OUTPUT FILTERS.................. 5
         INPUT SUPPRESSION............... +/-100MV
         GAIN............................ UP TO  X10,000


003210 SOUND LEVEL METER                                      LS923   11111
003210
003210 SOUND LEVEL SURVEYS AND LIMITED FREQUENCY ANALYSIS IN REAL TIME.
003210
003210      FREQUENCY RESPONSE ........... 125 TO 8000 HZ
003210      SOUND LEVEL RANGE ............ 40 TO 100 DB
003210
    BRUEL AND KJAER INSTRUMENTS    #3501/S            $2500         111
         CONFIGURATION ...................CONSISTS OF: 2203 SOUND LEVEL
                                          METER, 1613 OCTAVE BAND FILTER,
                                          4220 PISTON PHONE CALIBRATOR,
                                          MICROPHONES, ACCELEROMETERS AND
                                          CABLES

504500 STAINING SYSTEM - BACTERIOLOGICAL                      LS924   11111
504500
504500 STAIN AND FIX BIOLOGICAL SPECIMENS FOR MICROSCOPIC EXAMINATION.
504500
    VWR SCIENTIFIC DIV             #48420-050         $1715         113
         CONFIGURATION .................. BENCH EQUIPMENT

    BECKMAN INSTRUMENTS              PROTOTYPE                      125
         STATUS ......................... NOW ON SKYLAB
         CAPACITY........................ 8 BLOOD SMEARS,16 BACTERIA
                                          SLIDES WITH 1 FILLING
         ZERO GRAVITY USE................ YES
         WEIGHT.......................... 1783 GRAMS
         DIMENSIONS...................... 4.1X5.1X9INCHES
         REAGENT STORAGE LIFE............ 2 YEARS
         PREPARATION TIME................ ABOUT 15 MIN

171600 TASKBOARD - FORCE/TORQUE                               LS925   11111
171600
171600 MEASURE MAN'S CAPABILITY TO APPLY FORCES AND TORQUES IN A VARIETY
171600 OF DIRECTIONS FROM VARIOUS HAND/BODY ORIENTATIONS AND RESTRAINT
171600 CONDITIONS.
171600
171600      HAND FORCE APPLICATIONS ...... +/- 0.5 POUNDS
171600
    GENERAL ELECTRIC               #NAS 9-8640                      512
         CAPABILITIES ................... MEASURE ONE/TWO HANDED FORCE
                                          APPLICATIONS WITHIN +/- 0.5 LB.
                                          RESTRAIN TEST SUBJECT IN THE
                                          DESIRED POSITION.

301000 RADIATION COUNTER - BIOCHEMICAL SAMPLE                 LS926   11111
301000
301000 FAST, ACCURATE AND EASY BIOCHEMICAL RADIATION COUNTING SYSTEM
301000 BASED ON STANDARD SIZED BIOCHEMICAL SAMPLES.
301000
301000      STANDARD PLANCHET ............ UP TO 2 IN DIA
301000      CAPACITY OF PLANCHETS ........ 120
301000
    HEWLETT PACKARD                #5560A                           111
         CONFIGURATION .................. BENCH/LOOSE EQUIP
         TYPE ........................... NUCLEAR COUNTING SYSTEM, ULTRA-
                                          LOW BACKGROUND, GAS-FLOW OR
                                          SCINTILLATION DETECTORS

459605 MASS SPECTROMETER                                      LS928   11111
459605
459605 PROVIDE AN ANALYSIS OF AN UNKNOWN IONIZED GAS BY ATOMIC MASS
459605 NUMBER
459605
459605      MASS RANGE.....................0 TO 60 AMU
459605
004100 AIR PARTICLE SAMPLE COLLECTOR                          LS929   11111
004100
004100 AIR PARTICLE AND MICRO-ORGANISM SAMPLES FOR AIR QUALITY DETERMIN-
004100 ATION
004100
004100      AIRFLOW ...................... 1 CU FT/MIN
004100      SAMPLING TIME - CONTINUOUS ... 1 HOUR
004100
    BAUSCH - LOMB INC.             #40-1A
         SAMPLING RATE ............  0.1 CU.FT./100SEC.
                                     (0.17 LITERS/MIN.)
         MAX.CONCENTRATION MEAS ...  1E+7 PARTICLES/CU.FT.
                                      (35E+3 PARTICLES/LITER)
         PARTICLE SIZE RANGE ...... 0.3,0.5,1.0,2.0,3.0,5.0,10MICRONS

042000 AUTOANALYZER - MULTIPLE                                LS930   11111
042000
042000 AUTOMATIC ANALYSIS OF BLOOD AND APPROXIMATELY 30 OTHER FLUIDS.
042000
460300 SPECTROPHOTOMETER - GENERAL ANALYZER                   LS931   11111
460300
460300 SPECTRAL ANALYSIS OF GASES AND LIQUIDS INCLUDING SOLIDS OR LIGHT
460300 SOURCES.
460300
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460300     FREQUENCY ....................... 250 TO 2500 NANOMETERS
460300                                       (2500 TO 25000 ANGSTRONS)
460300     ACCURACY ........................ +/- C.4 NANOMETERS
460300
    VARIAN INSTRUMENTS             #CARY 14           $22000          112
        CONFIGURATION ...................... BENCH EQUIP
        WAVELENGTH RANGE ................... 1860 A TO 2.65 MICRONS
        ACCURACY ........................... +/- 4 A
        REPRODUCIBILITY .................... < 0.5 A IN UV-VIS
                                             < 2.5 A IN NEAR IR

    CARY                           #IMMLMS
        FREQ RANGE ......................... 200 TO 7CO NM
        RESOLUTION ......................... +/- 0.5 NM
        PHOTOMETRIC ACCURACY ............... +/- 0.3%
        BANDWIDTHS ......................... 0.5 OR 5.0 NM

    SHIMADZU                       #AQV-5CO           $3500
        WAVELENGTH RANGE.................... 183 TO 1200NM
        ACCURACY............................ 0.1%
        RESOLUTION.......................... 0.05M AT 205NANOMETERS
        PHOTOMETRIC ACCURACY................ +/-0.2%
        BANDWIDTHS..........................10C TO 30C, 300 TO 40C, 403 TO
                                             60C, 600 TO 850 AND 850 TO 1200
                                             NANOMETERS

    CORNING                        #240               $5450           111
        FREQUENCY RANGE .................... 190 TO 800NM
        RESOLUTION ......................... +/- 0.045UNITS FULL SCALE

    PERKIN ELMER INSTRUMENT DIV   #323                $15200
        WAVELENGTH RANGE ................... 185 TO 2500 NANOMETERS
        MODES .............................. X-Y RECORDER
                                             AUTOMATIC REPETATIVE SCAN

    G K TURNER ASSOCIATES          #350               $1609           111
        WAVELENGTH RANGE ................... 210 NM TO 1000 NM
        ACCESSORIES ........................ 330-030 IR ACCESSORY
                                             330-040 UV ACCESSORY
        CPTICS ............................. REFLECTION TYPE
        WAVELENGTH ACCURACY ................ +/- 2 NM
        WAVELENGTH READOUT ................. DIGITAL IN NM
        PHOTOMETRIC METER ACCURACY ......... +/- 0.5%

    BECKMAN INSTRUMENTS            #ACTA M-VII 133700  $23000         112
        SPECTRAL RANGE...................... 19C -800NM (PHOTOMULT TUBE)
                         ................... 800 -3000NM(LEAD SULFIDE CELL)
        RESOLUTION.......................... BETTER THAN .05NM(190-800NM)
                  .......................... BETTER THAN .3NM (800-3000NM)
        PHOTOMETRIC ACCURACY................ .003AT 1.0A .03 AT 3.0A
        CHART SPEEDS........................ .02 TO 4NM/SEC (190-800NM)
                     ....................... .Ce TO 16NM/SEC(800-3000NM)
        SCAN EXPANSION...................... 1 TO 100NM/INCH(190-800NM)
                       ..................... 4 TO 400NM/INCH(800-3030NM)
        DIMENSIONS.......................... 24X62X22INCHES(61X157X56CM)
        WEIGHT.............................. 250 LBS (113KG)

000590 ANESTHETIZER - INVERTEBRATES                       LS932    11114
000590
000590 RENDER INVERTEBRATE ORGANISMS INSENSIBLE TO FACILITATE HANDLING.
000590
000590     ANESTHETIC GAS ................ CARBON DIOXIDE
000590
146915 ANTHROPOMETRIC GRIC                                LS933    11111
146915
146915 ANTHROPOMETRIC MEASUREMENTS OF VERTEBRATES EITHER REMOTELY CR
146915 AUTOMATICALLY.
146915
146915     SMALL GRID ..................... 5 X 15 CM SPACED AT 1 MM
146915     MEDIUM GRID .................... 50 X 75 CM SPACED AT 2 MM
146915     LARGE GRID ..................... 2 X 2 M SPACED AT 5 MM
146915
107000 BENCH, LAMINAR AIRFLOW                             LS934    11114
107000
107000 A GLOVE BOX WITH RELATIVELY HIGH AIR FLOW FOR CONTROL OF
107000 PARTICULATE AND GASEOUS CONTAMINANTS WITHIN
107000
107000 BENCH, GENERAL EXPERIMENTS                         LS935    11134
107000
107000 PROVIDE WORK AREA FOR PREPARATION OF EXPERIMENTS, EXPERIMENT
107000 MAINTENANCE OBSERVATICNS, AND PREPARATIONS FOR RETURN TO EARTH
107000
107000     ELECTRICAL UTILITY.............28VDC, 400HZ AC, 60HZ AC
107000     VACUUM UTILITY.................10E-6 TORR
107000     PRESSURE SOURCE................50 PSIG (3.45E4 N/M2)
107000     AVAILABLE GASSES...............CXYGEN, NITROGEN, CARBCN DIOXIDE
107000
055055 CAMERA CINE                                        LS936    11111
055055
055055 PROVIDE VISUAL RECORDS SUCH AS PHOTOMICROGRAPHY,  TIME LAPSE
       RECORDS, PHOTOMICROSCOPY AND GENERAL EXPERIMENT DOCUMENTATION
055055
055055     OPERATION MODE.................VARIABLE FRAME RATE CR SINGLE
055055                                      FRAME PULSE OPERATION UNDER
055055                                      REMOTE CONTROL
055055     FILM SIZE......................16 OR 35MM
           LENS SELECTICN.................*C* MOUNT LENS SYSTEM; STANDARD
055055                                    ZOOM LENS AS A MINIMUP
055055     EXPOSURE SYSTEM................AUTOMATIC OR ZOOM
055055     FILM CAPACITY.................. 50, 100 OR 200FT (15.2,30.4 OR
055055                                      60.8M) ROLLS
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059055
    J A MAURER INC                #3C8             $15 - 20,000      511
        FILM ............................ 16 MM DOUBLE OR SINGLE PERFOR-
                                          ATED
        FORMAT .......................... 0.295 X 0.404 INCH
        FRAME RATE ...................... 1, 6, 12 AND 24 FR/SEC, TIME
        SHUTTER SPEED ................... TIME, 1/60, 1/125, 1/250, 1/500
                                          AND 1/1000 SEC
        FILM CAPACITY ................... 90 FT STD-BASE FILM, 145-165 FT
                                          THIN-BASE FILM
        FLOWN ON APOLLO

    J A MAURER INC                #ODYSSEY 16                        511
        FRAME SPEED ..................... 8-56 FPS
        LENS MOUNT ...................... WIDEBASE BAYONET TYPE
        MAGAZINE ........................ 400 FT
        ASA ............................. 8 TO 500

    BEATTIE-COLEMAN               #KD-5                              111

603014 CAMERA CONTROLLER                                   LS937   11114
603014
603014 DEVICE TO CONTROL THE OPERATION OF VIDEO CAMERAS THROUGHOUT THE
603014 LABORATORIES
603014
059050 CAMERA, PLATE FILM                                  LS938   11111
059050
059050 PROVIDE STILL PHOTOGRAPHIC COVERAGE
059050
059050     FILM TYPES.......................HIGH RESOLUTION GLASS PLATE
059050              ........................STANDARD 2 1/4 X 2 1/4 IN (5.75
059050                                       X 5.75 CM) ROLL
059050              ........................70MM
059050              ........................POLAROID
059050     SHUTTER SPEED....................1 SEC TO 1/500 SEC
059050
    HASSELBLAC                    #500 EL             $1411          111
        TYPE ............................ SINGLE LENS REFLEX
        DRIVE ........................... ELECTRICAL OR MANUAL
        LENS ............................ 80 MM PLANAR F/2.8 ZEISS
                                          50 MM DISTAGON F/4.0
        CLOSE-UP LENS ................... PROXAR 0.5 FOCUS RANGE
                                          17.25 TO 24.25 IN
                                          PROXAR 1.0 FOCUS RANGE
                                          22.25 TO 42.5 IN
        FILM SIZE ....................... 2.25 X 2.25 IN
        MAGAZINE ........................ CASSETTE AND PLATE

    TEKTRONIX INC                 #C-12               $590           111
        LENS ............................ 75 MM
        STOP ............................ F/1.9 TO F/16
        MAGNIFICATION ................... 0.85
        LENS SPEED ...................... 1 TO 1/100 SEC MECH
                                          4 TO 1/60 SEC ELECT
        FILM TYPE........................ POLAROID

    TEKTRONIX                     #C30                $525
        MAXIMUM RELATIVE APERTURE........ F/1.9
        MAGNIFICATION.................... 0.7 TO 1.5
        RELATIVE SPEED................... 1.0
        FIELD OF VIEW.................... 3.15X3.93IN (8X10CM)
        FILM TYPE........................ POLAROID

    HEWLETT-PACKARD               #198                $420
        MAXIMUM RELATIVE APERTURE........ F/3.5
        MAGNIFICATION.................... 1:0.85
        SPEED............................ 8 TO 1/60 SEC
        LENS............................. 75MM
        FILM TYPE........................ POLAROID

    HEWLETT-PACKARD               #195A               $1025
        MAXIMUM RELATIVE APERTURE........ F/1.3
        MAGNIFICATION.................... 1:0.5
        SPEED............................ 8 TO 1/30 SEC
        LENS............................. 80MM
        FILM TYPE........................ POLAROID

480000 VIDEO CAMERA, B/W                                   LS939  401131
480000
480000 PROVIDE MEANS OF ACTIVITY MONITORING, EXPERIMENT DATA ACQUISITION
480000 ETC. SYSTEM WILL INTERFACE WITH A 40 INPUT VIDEO MULTIPLEXER TO
480000 PERMIT THE MONITORING OF 40 SIMILAR VIDEO CAMERAS.
480000
480000     VISUAL RESPONSE..................APPROXIMATE HUMAN EYE
480000     VIDEO OUTPUT.....................CONSTANT WITH LIGHT LEVEL
480000                                      CHANGES OF 10 TO 10000FT CANDLES
480000                                      1.4V P-P COMPOSITE, CONFORMS TO
480000                                      EIA RS-170 STANDARD
480000
    GENERAL ELECTRODYNAMICS CORP  #EC 6030 A-1        $10000         411
        CONFIGURATION ................... LOOSE EQUIP
        TYPE ............................ ELECTROSTATIC FOCUS VIDICON
                                          TUBE, PLUG-IN PRINTED CIRCUITS,
                                          SOLID STATE SYSTEM
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        RESOLUTION ........................ 700 LINES
        CHANNELS .......................... 1
        VIDICON ........................... 1 INCH 101339
        LENS .............................. C MOUNT
        VIDEO OUTPUT ...................... 1.4 V P-P COMPOSITE (ATC 75 OHM
        AUTOMATIC CONSTANT VIDEO OUTPUT. 10 TO 10,000 FT-CANDLES
        HORIZONTAL SCANNING FREQUENCY .. 15,750 HZ
        VERTICAL SCANNING FREQUENCY .... 60 HZ
        INTERLACE ......................... 2:1 30 FR/SEC
        ASPECT RATIO ...................... 3:4
        SWEEP LINEARITY ................... > 1%

    RCA ELECTRONICS COMPONENTS     #8521               $520          111
        TYPE .............................. VIDICON-SULFIDE
        PHOTOCONDUCTOR .................... 11
        IMAGE DIAGONAL .................... 25 MM (1 IN)
        FOCUS ............................. MANUAL

    COHU INC. ELECTRONICS DIV.     #1220               $6430         111
        IMAGE CONVERTER ................... 4846P VIDICON - COLOR
        RESOLUTION-HORIZONTAL LIMIT .... 300 LINES MIN.
        GEOMETRIC DISTORTION ............ < 2 % OF PIC HEIGHT
        LENS MOUNT ........................ 16 MM - C-MOUNT

    COHU INC. ELECTRONICS DIV.     #2000               $3000         311
        LENS-BUILTIN ...................... 4:1 (20-80 MM) F/2.5 ZOOM
        LENS ATTACHMENT ................... 4:1 (12.5-80 MM)
        LENS INTERCHANGEABLE ............ 10:1 (15-150 MM) F/2.8 ZOOM
                             ............ 16 MM C-MOUNT FFL
        10 MHZ BANDWIDTH (MOD 2006) .... 525 OR 725 LINE (VIDICON 7263A)
        20 MHZ BANDWIDTH (MOD 2004) .... 873 OR 945 LINE (VIDICON 8573)
        MIL SPECIFICATIONS .............. MIL-E-5272C, MIL-STD-810

    COHU INC. ELECTRONICS DIVISION#4500                $2225         311
        LENS .............................. 4:1 ZOOM
             ............................. 10:1ZOOM
        VERTICLE SWEEP RATE ............. 60FIELDS PER SEC
        HORIZONTAL SWEEP RATE ........... 525 LINES PER FRAME
        IMAGE TUBE TYPE ................... 9541A STD
        LENS MOUNT                          16 MM C-MOUNT
        MIL SPECIFICATIONS .............. MIL-E-5400M, MIL-E-5300M

481000 VIDEO CAMERA, COLOR                                    LS940   11111
481000
481000 PROVIDE COLOR VIDEO OBSERVATIONS OF EXPERIMENTAL ANIMALS, SETUPS,
481000 ETC. FOR STORAGE VIA VIDEO-TAPE FOR TRANSMISSION TO THE GROUND.
481000
481000     RESOLUTION (MIN)...................350 LINES
481000     LENS...............................STANDARD 16MM, C MOUNT
481000
    COHU ELECTRONICS INC           #1000/1900/5800     $20000        111
        CONFIGURATION ..................... BOTH LOOSE AND RACK-MOUNT EQUIP
        COLOR SYSTEM ...................... 3 VIDICON SYSTEM
        LENS .............................. C MOUNT VIDICON-FORMAT
        RESOLUTION (GREEN CHANNEL) ..... LIMITING AT 500 LINES, 50% AT
                                            400 LINES, 100% AT 300 LINES
        SCAN LINEARITY .................... < 1%
        VIDEO OUTPUT ...................... 0.7 V P-P WITH 300 FOOTLAMBERTS

    COHU INC. ELECTRONICS DIV.     #1220               $8430         111
        IMAGE CONVERTER ................... 4846P VIDICON - COLOR
        RESOLUTION-HORIZONTAL LIMIT .... 300 LINES MIN.
        GEOMETRIC DISTORTION ............ < 2 % OF PIC HEIGHT
        LENS MOUNT ........................ 16 MM - C-MOUNT

    COHU INC. ELECTRONICS DIV.     #2000               $3000         311
        LENS-BUILTIN ...................... 4:1 (20-80 MM) F/2.5 ZOOM
        LENS ATTACHMENT ................... 4:1 (12.5-80 MM)
        LENS INTERCHANGEABLE ............ 10:1 (15-150 MM) F/2.8 ZOOM
                             ............ 16 MM C-MOUNT FFL
        10 MHZ BANDWIDTH (MOD 2006) .... 525 OR 729 LINE (VIDICON 7263A)
        20 MHZ BANDWIDTH (MOD 2004) .... 873 OR 945 LINE (VIDICON 8573)
        MIL SPECIFICATIONS .............. MIL-E-5272C, MIL-STD-810

    COHU INC. ELECTRONICS DIVISION#4500                $2225         311
        LENS .............................. 4:1 ZOOM
             ............................. 10:1ZOOM
        VERTICLE SWEEP RATE ............. 60FIELDS PER SEC
        HORIZONTAL SWEEP RATE ........... 525 LINES PER FRAME
        IMAGE TUBE TYPE ................... 9541A STD
        LENS MOUNT.........................16 MM C-MOUNT
        MIL SPECIFICATIONS .............. MIL-E-5400M, MIL-E-5300M

068500 CENTRIFUGE,REFRIGERATED,HIGH SPEED                     LS941   11111
068500
068500 SEPARATION EQUIPMENT TO SUPPORT MEDICAL AND BIOLOGICAL RESEARCH.
068500
068500     OPERATING TEMPERATURE..........35 TO 50F (2 TO 10C)
068500     SPEED..............................0 TO 20000RPM
068500
    BECKMAN INSTRUMENTS            #J-21B+JA-20        $3450         111
        SPINNING RATE...................... 0-20000 RPM
        APPLIED GRAVITY.................... 0-48300 "G"
        ACCOMODATION ...................... 8-50 ML TUBES
        ROTOR ............................. #JA-20
        TEMPERATURE ....................... -15C AT REDUCED SPEED
                    ....................... 2 C TO 30 C FULL SPEED
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INTERNATIONAL EQUIPMENT CO    #PR-2                    $3100          112
     SPINNING RATE ..................... 0 TO 9100  RPM
     SEPARATION FORCE .................. TO 25000 G
     TEMPERATURE ....................... -15 TO 30 C
     AUTOMATIC TIMER ................... 2 MIN TO 2 HRS (ADJUSTABLE)

INTERNATIONAL EQUIPMENT CO    #HR-1                    $3100          112
     SPINNING RATE ..................... 0 TO 20000 RPM
     SEPARATION FORCE .................. TO 60000 G
     TEMPERATURE ....................... -20 TO 40 C
     ACCOMODATION ...................... 8 PLACES, 50 ML
     AUTOMATIC TIMER ................... 2 TO 120 MINUTES

INTERNATIONAL EQUIPMENT CO    #B-20                    $3100          112
     SPINNING RATE ..................... 20000 RPM
     SEPARATION FORCE .................. 40000 G
     TEMPERATURE ....................... -30 TO 30 C
     LOAD ACCOMODATIONS ................ 12 X 14 ML

BECKMAN INSTRUMENTS INC       #L5-50                   $9450
     SPINNING RATE ..................... 0-50000 RPM
     APPLIED GRAVITY ................... 0-54000 G
     ACCOMODATIONS ..................... 1.5 ML CAPACITY
     TEMPERATURE ....................... 0 C TO AMBIENT

MSE                           #LR-6                    $3450          111
     ADD HIGH SPEED ATTACHMENT
     SPINNING RATE...................... 22000RPM
     APPLIED GRAVITY.................... 37500"G"
     TEMPERATURE........................-4 TO  104F (-20 TO 40C)

068000 CENTRIFUGE, MICRO                                      LS942   11111
068000
068000 CENTRIFICAL SEPARATION OF BIOLOGICAL SAMPLES
068000
068000    CAPACITY.......................4 SAMPLES
068000    SPEED(MIN).....................1750RPM
068000    GLASS TUBE SIZES.............. 0.5 TO 5 ML
068000
INTERNATIONAL EQUIPMENT CO    #20211/20215/20216      $86            112
     CONFIGURATION ..................... BENCH/LOOSE EQUIP
     APPLICATION ....................... MICRO OR SEMI-MICRO ANALYSIS
     SPINNING SPEED .................... 1780 RPM
     SPIN STABILIZATION TIME............ 10 SEC
     ACCOMODATIONS ..................... 0.5, 1, 2, 3, 5 ML TUBES

ADAMS                         #DYNAC                   $267
     SPINNING RATE...................... 700 TO 2500RPM
     APPLIED GRAVITY.................... 65 TO 1080 RCF
     SAMPLE CAPACITY.................... 24

MSE                           #GT-4                    $410           111
     SPINNING SPEED..................... 4000RPM
     APPLIED GRAVITATION................ 2900
     SAMPLE CAPACITY.................... 4

BAUSCH AND LOMB INC           #SYSTEM CENTRIFUGE                      112
     CAPACITY .................. 100 SAMPLES
     TIME TO SPIN DOWN ......... 3 MINUTES
     MAX.INBALANCE ............. 2 TUBES
     SPEED ..................... UP TO 4000RPM
     RCF ....................... 2000 AT 4000RPM

CLAY-ADAMS, INC               #1004                    $324
     SPEED RANGE.........................800 TO 3040 RPM
     SAMPLES.............................12 (MAX), 15 ML EACH
     DIMENSIONS..........................15X12X26 INCHES
     CONFIGURATION.......................BENCH MOUNT

BECKMAN INSTRUMENTS           #152                     $245           111
     SPINNING RATE...................... 0 TO 16000 RPM
     ACCOMODATION ...................... .4ML TUBES(20)
     DIMENSIONS . ...................... 9X7X7 INCHES
     WEIGHT ..... ...................... 13 LBS(SHIPPING)
     POWER ............................. 115V 50/60 HZ
     DEVELOPED G ....................... 13000

603015 VACUUM CLEANER                                         LS943   11111
603015
603015 COLLECT GENERAL LABORATORY WASTE MATERIALS, DIRT, DUST AND DEBRIS
603015
603015    VACUUM BAG VOLUME.............0.36CU.FT. (10.2LITERS)
603015
603016 CLINOSTAT                                              LS944   11111
603016
603016 MOTOR DRIVEN MOUNTING STRUCTURE TO PROVIDE CONTINUOUS ROTATION
603016 OF PLANT SAMPLES
603016
603016    ROTATION RATES..................TBD
603016    PLATFORM LIGHTING...............TBD
603016
338000 COMPACTOR, WASTE SOLIDS                                LS945   11111
338000
338000 COMPACTS WASTE SOLIDS FOR EASY HANDLING
338000
338000    COMPACTION(MIN)................1/4 INITIAL VOLUME
338000
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SEARS, ROEBUCK AND CO                                     $200        112
     VOLUME ............................. 0.2 M**3 (7.2 FT**3)
     COMPACTION (FINAL VOL) ....1/4 INITIAL VOL

090470 CONSOLE,BEHAVIORAL MEASUREMENTS                      LS946   11114
090470
090470 DEVICE THAT MEASURES MENTAL PROCESSES, ATTITUDES, ETC. SUCH AS
090470 COGNITIVE PROCESSES, INDIVIDUAL BEHAVIORAL TRAITS, GROUP
090470 BEHAVIORAL TRAITS, ETC. CONSOLE INCLUDES GENERAL PURPOSE DISPLAY
090470 AND GENERAL PURPOSE RESPONCE KEYBOARD
090470
090470    PROCESSES MEASURED............COMPLEX PERCEPTUAL
090470                      ............CONCEPTUAL AND THINKING ABILITY
090470                      ............MEMORY
090470                      ............REACTION TIME-SIMPLE AND COMPLEX
090470                      ............INDIVIDUAL BEHAVIORAL TRAITS
090470                      ............GROUP BEHAVIORAL TRAITS
090470
102500 DIGITAL COMPUTER
102500                                                       LS947   11111
102500 PROVIDE AUTOMATIC DATA ACQUISITION OF EXPERIMENTAL DATA, CONTROL
102500 LIGHTING AND ANIMAL FEEDING AND GENERAL LABORATORY ENVIRONMENT
102500 MONITORING. THE COMPUTER WILL SUPPORT ANALYTICAL TOOLS SUCH AS
102500 MASS SPECTROMETERS, GAS ANALYZERS AND DIALYSIS EQUIPMENT, ALSO
102500 DRIVES ONE OR MORE CRT INTERACTIVE DISPLAY CONSOLES
102500
102500    MEMORY CAPACITY................16BIT 16,000 WORD
102500    CYCLE TIME.....................1MICROSECOND
102500    PERIPHERAL CAPABILITIES........DIRECT MEMORY ACCESS
102500                           .......FLEXIBLE INTERRUPT STRUCTURE
102500                           .......SINGLE BIT SET AND SENSE LINE
102500                                    CAPABILITY OF UP TO 64 LINES
102500                                    EACH
102500
   DATA GENERAL CORP              #NOVA 800          $10450        111
      WORD LENGTH ...................... 16 BIT
      CYCLE TIME ....................... 800 NANOSEC.
      CORE MEMORY ...................... 32K MAX

   DATA GENERAL CORP              #SUPERNOVA SC      $5600
      WORD LENGTH ...................... 16 BIT

   DATA GENERAL CORP              #NOVA 1200         $11900
      WORD LENGTH ...................... 16 BIT
      CYCLE TIME ....................... 1200 NANOSEC.
      CORE MEMORY ...................... 32K MAX.

   VARIAN DATA MACHINES           #520/I                           111
      MEMORY CYCLE TIME ................ 1.5MICROSEC.
      MEMORY ........................... EXPANDABLE,4096BYTES(8BITS)TO
                                         32,768BYTES
      REGISTERS ........................ 12
      OPERAND PRECISION ................ UP TO 32 BITS
      ADDRESS REFERENCE ................ 8,16,24,OR 32 BIT LEVEL
      NOTE:                              HAS FULL RANGE INTERFACE
                                         HARDWARE

   VARIAN DATA MACHINES           #R-620/I                         111
      BASIC COMMANDS ................... OVER 100
      ADDRESSING MODES ................. 6
      MAX.WORDS ........................ 32,768
      WORD LENGTH ...................... 16 OR 18 BIT
      REGISTERS ........................ 9
      NOTE:
                                         HAS FULL RANGE INTERFACE
                                         HARDWARE

   CLARY DATACOMP SYSTEMS INC     #404                             111
      SIMULTANEOUS TERMINALS ......... 16
      INPUT ............................ TELETYPEWRITER KEYBOARD
      ACCUMULATOR ...................... 64 BIT
      REGISTERS ........................ 16 BIT INDEX (2 EACH)
      WORD LENGTH ...................... 16, 32, 48, 64 BITS
      MEMORY CAPACITY .................. 1024 16 BIT WORDS, 4096 16 BIT
                                         WORDS,OR ADDITIONAL 4096 16 BIT
                                         WORDS. TOTAL 65530 WORDS

   GENERAL AUTOMATION INC.        #18-30                           111
      FUNCTION ......................... SUPERVISES SMALLER COMPUTERS
      MEMORY............................ 8K CORE
      CYCLE TIME ....................... 1.2 MICROSEC.

   GENERAL AUTOMATION INC.        #SPC-16                          111
      MEMORY ........................... 16K
      WORD LENGTH ...................... 16 BITS
      READ/WRITE CYCLE MEMORY TIME ... 800 TO 1440 NANOSEC.
      READ ONLY MEMORY ................. 400 TO 720 NANOSEC.
      INPUT/OUTPUT TIME ................ 1.6 TO 2.0 MICROSEC.
      DMA TRANSFER RATE ................ 0.694E+06 TO 2.5E+06

   GENERAL AUTOMATION INC.        #SPC-12                          111
      MEMORY ........................... 4K TO 16K
      WORD LENGTH ...................... 8 BITS
      CYCLE TIME ....................... 2.16 MICROSEC
      STORED PROGRAM EXECUTION RATE .. 0.23E+06/SEC
      I/O TRANSFER RATE ................ 0.46E+06/SEC
      REGISTERS ........................ 6 12 BIT REGISTERS
      ACCUMULATORS ..................... 4 12 BIT
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    DIGITAL EQUIPMENT CORP          #PDP-8/F            $22000         111
        MEMORY .......................... 4096(CORE)EXPANDABLE TO
                                          32,768 WORDS
        WORD ............................ 12 BIT
        CYCLE TIME ...................... 1.5 MICROSEC.
103500 ANALOG TO DIGITAL CONVERTER                          LS948    11111
103500
103500 SUPPORT DIGITAL COMPUTER. INCLUDES LO-LEVEL MULTIPLEXER. UNIT
103500 SHOULD BE A PROGRAMMABLE GAIN 12 BIT TYPE
103500
105004 DISK STORAGE SYSTEM                                  LS949    11111
105004
105004 STORES DATA IN SUPPORT OF COMPUTER
105004
105004    STORAGE CAPACITY ..............5.0E6 WORDS
105004
    ANALOG DEVICES INC.             #ADC-8S             $79            111
        RESOLUTION                        8 BITS
        ERROR                             +/-0.2%
        CONVERSION TIME                   1 MILLISEC.

    ANALOG DEVICES INC.             #ADC-1202           $305           111
        RESOLUTION                        12 BITS
        ERROR                             +/-0.0125%
        CONVERSION TIME                   25MICROSEC.

    ANALOG DEVICES INC              #ADC-16Q            $1350          111
        RESOLUTION                        16BITS
        ERROR                             +/-0.0015%
        CONVERSION TIME                   400MICROSEC.

    TENNELEC                        #TC500              $6000          111
        CONVERSION TIME.................. 3MICRO SEC
        CONFIGURATION.................... COMPATIBLE WITH NIM
        CAPACITY......................... 2048 CHANNELS

    TENNELEC                        #TC 520             $750           111
        CHANNELS......................... 8
        CHANNEL DWELL TIME............... 300NSEC
        CONFIGURATION.................... NIM COMPATIBLE

    ROHDE AND SCHWARZ               #UCM 210/1                         111
                                     (221.5603.02)
        ANALOG INPUT RANGE .............. +12 TO -12 VOLTS
        SAMPLING RATE ................... > 10000 MEAS/SEC (POSITIVE)
                                          > 17000 MEAS/SEC (NEGATIVE)
        DATA OUTPUT ..................... 3+1 DECADES (BCD CODE PARALLEL)
                                          0-1200 PULSES (SERIAL)

424000 MAGNETIC TAPE RECORDER                               LS950    11111
424000
424000 RECORD DATA
424000
424000    DATA RATE .....................30+ BPS
424000    TOTAL DATA STORED .............16.0E09 BITS
424000
    AMPEX CORPORATION               #AR-200                            121

        BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                          300 HZ TO 250 KHZ
        TAPE WIDTH ...................... 0.5 INCH
        TAPE SPEED ...................... 1.875 TO 60 IPS
        RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
        FORMAT .......................... DIGITAL
        TRACKS .......................... 8 DIGITAL, 7 ANALOG

    AMPEX CORP                      #AR 1700            $28,000        112
        TRACKS .......................... 14
        TAPE SPEED ...................... 120 IPS
        TAPE WIDTH ...................... 1 INCH
        RECORDING MODE................... DIRECT
        PACKING DENSITY ................. 20 KB/I/T
        SIGNAL/NOISE .................... 20 DB
        DATA CAPACITY ................... 6.2E+10
        BANDWIDTH ....................... 2 MB/SEC/T

    SANGAMO ELECTRIC                #SABER III          $26,500        111
        TRACKS .......................... 14
        TAPE WIDTH ...................... 1 INCH
        TAPE SPEEDS...................... 8 SELECTABLE SPEEDS FROM 15/16
                                          TO 120 IPS
        FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
        RECORDING RATE .................. 600 KBPS AT 120 IPS SERIAL MODE
        WEIGHT .......................... 100 POUNDS

    DIGI-DATA CORPORATION           #1600               $2650          111
        TAPE SPEED ...................... 25, 18.75, 12.5 IPS
        TRACKS .......................... 7 OR 9 TRACK
        DATA DENSITY .................... 1600 CPI PHASE ENCODED
                                          200, 556, 800 CPI NRZI
        TAPE ............................ 0.5 INCH, 1.5 MIL, 1200 FEET

    DIGI-DATA CORPORATION           #1700/PDP-11/7-9    $5250          111
                                     TRACK NRZI
        TAPE SPEED ...................... 45, 37.5, 25, 18.75, 12.5 IPS
        TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                          COMPATIBLE, 10.5 INCH REEL
        TRACKS .......................... 7 OR 9
        DATA DENSITY .................... PHASE ENCODED
                                          COMPATIBLE
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HEWLETT PACKARD               #7970B/C          $ 4600       111
    TAPE FORMAT ..................... 800, 556, OR 200 CPI NRZI AND
                                      1600 CPI PHASE-ENCODED
    CHANNELS ........................ 7 OR 9
    TAPE SPEED ...................... 10 TO 45 IPS
    TAPE ............................ 0.5 INCH, 1.5 MILS, IBM/ANSI
                                      COMPATIBLE

BORG WARNER                   #PERT                          121
    TRACKS .......................... 30
    TAPE SPEED ...................... UP TO 1000 IPS
    TAPE WIDTH ...................... 1/2 INCH
    TAPE LENGTH ..................... 2400 FEET
    PACKING DENSITY ................. 15 KB/I/T
    SIGNAL/NOISE .................... 24 DB
    DATA CAPACITY ................... 1.3E+9
    BANDWIDTH ....................... 6-15 MB/SEC/T

LEACH                         #MTR 7000                      311
    TRACKS .......................... 12
    TAPE SPEED ...................... 120 IPS
    TAPE WIDTH ...................... 1 INCH
    TAPE LENGTH...................... 9200 FEET
    PACKING DENSITY.................. 16.7 KB/I/T
    SIGNAL/NOISE .................... 22 DB
    DATA CAPACITY ................... 2.2E+10
    BANDWIDTH ....................... 2 MB/SEC/T
HEWLETT PACKARD               #3955D            $10200       111
    BANDWIDTH ....................... 300 KHZ
    CHANNELS ........................ 7
    RECORDING FORMAT ................ DIRECT OR FM

HEWLETT PACKARD               #3955C            $14700       111
    BANDWIDTH ....................... 300 KHZ
    CHANNELS ........................ 14
    RECORDING FORMAT ................ DIRECT OR FM

HEWLETT PACKARD               #3950A-C11        $23800       111
    BANDWIDTH ....................... 500 HZ TO 2 MHZ
    CHANNELS ........................ 14
    RECORDING FORMAT ................ DIRECT OR FM

HEWLETT PACKARD               #3960A/13065A/13063A $4796     111
    CONFIGURATION ................... RACK MOUNTED
    TAPE SPEED ...................... 15, 3 AND 3/4, 15/16 IPS
    CHANNELS ........................ 4
    RECORDING FORMAT ................ FM
    PASSBAND ........................ 5 KHZ
    S/N RATIO........................ 48 DB
    TRACKS .......................... 30

HONEYWELL                     #5600             $9730
    PORTABLE TAPE RECORDER
    CHANNELS......................... 7
    SELECTABLE TAPE SPEED RANGE...... 15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)........ 300KAZ
    PACKING DENSITY.................. UP TO 600PBI
    WEIGHT........................... 70LBS (32KG)
    INPUT VOLTAGE....................28VDC

HONEYWELL                     #96               $17420
    CHANNELS......................... 7
    SELECTABLE TAPE SPEED RANGE...... 15/16 TO 240IPS
    REEL SIZE........................ 16IN
    MAXIMUM BANDWIDTH(DIRECT)........ 2M HZ
    TAPE WIDTH....................... 1/2 IN

AMPEX CORP                    #AP 70C           $29,180      511
    TRACKS .......................... 14
    TAPE SPEED ...................... 60 IPS
    TAPE WIDTH ...................... 1 INCH
    RECORD MODE...................... DIRECT
    PACKING DENSITY ................. 20 KB/I/T
    SIGNAL/NOISE .................... 20 DB
    DATA CAPACITY ................... 8E+10 BITS
    BANDWIDTH ....................... 1 MB/SEC/T


104180 CRT DISPLAY                                  LS951   41111
104180
104180 DISPLAY GRAPHIC AND ALPHANUMERIC DATA
104180
    RESEARCH INC              #3300             $1580
        FORMAT...........................24 LINESX72 OR 80 CHARACTERS
               ..........................24 LINESX40 CHARACTERS
               .......... ............... 12 LINESX72 OR 80 CHARACTERS
        REFRESH RATE.....................60 HZ
        TRANSFER RATE....................110 TO 2400 BAUD
        CHARACTER FORM...................5X7 DOT MATRIX
        DIMENSIONS.......................15-1/2WX13-1/2HX23-1/2D INCH
        WEIGHT...........................39LB (17.7KG)

    HEWLETT PACKARD           #2600A            $3580        111

    RESEARCH INC              #812-3301         $1555        111
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        SCREEN FORMAT ..................... 12 LINES X 72 OR 80 CHARACTERS,
                                            24 LINES X 40 CHARACTERS
        CHARACTER FORMAT .................. 5 X 7 DOT MATRIX
        TRANSFER RATE ..................... 110 TO 2400 BAUD, 10 OR 11 BIT
                                            CHARACTERS
        MODES ............................. HALF OR FULL DUPLEX-SWITCHABLE
                                            LOCAL OR REMOTE

    RESEARCH INC                  #DPS-812            $21,700         111
        COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
        DEC-PDP8-F MINI-COMPUTER, #3301 OPERATORS  CONTROL CONSOLE,
        PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
        CHANNELS ....................... 32
        MEMORY SIZE .................... 8K WORDS

    TEKTRONIX INC                 #4002A/021-0033-00/ $10975          111
                                   021-C0XX-00/4901/
                                   4551

        ALPHANUMERIC FORMAT ............... 39 LINES-85 NORMAL/ITALIC CHAR,
                                            1 LINE- 84 CHAR IN SCRATCH AREA
        CHARACTER SET ..................... 96 UPPER/LOWER CHAR (ASCII)
        CHARACTER SIZE .................... 70 X 90 MILS
        CHARACTER GENERATION .............. 7 X 9 DOT MATRIX
        CURSOR ............................ PULSATING 7 X 9 MATRIX
        GRAPHIC INPUT MODE ................ 1024(X) X 1024(Y) ADDRESSABLE,
                                            1024(X) X 761(Y) VIEWABLE PTS;
                                            JOYSTICK CONTROLLED, CROSS-HAIR
                                            CURSOR.
        DISPLAY MEDIUM ............ 11 IN DIA CRT
        DISPLAY AREA .............. 8.3IN.HOR.X6.1IN.VERT.
        ACCUMULATORS .............. 4
        CYCLE TIME ................ 300 NANOSEC
        CORE MEMORY ............... 32 K

    BUNKER-RAMO CORP              #2217-12CRT                         111
        CHARACTER CAPACITY (MAX) .......... 960
        CHARACTERS/LINE (MAX) ............. 80
        LINES/DISPLAY (MAX) ............... 24
        CHARACTERS REPERTOIRE ............. 62 OR 92
        VIEWING AREA ...................... 8.75 X 6.25
        REFRESH AREA ...................... 54 FRAMES/SEC

096000 ALTOMATIC COLONY COUNTER                              LS952   11111
096000
096000 DETERMINE THE NUMBER OF VIABLE COLONIES GROWING ON AN ALGUR
096000 SUPSTRATE
096000
    AMERICAN OPTICAL CORP         #3330               $115            112
        REGISTER........................... MODEL AO 3348 USED TO OBTAIN
                                            CUMULATIVE RECORDING OF COUNTS
        TYPE .............................. QUEBEC COLONY COUNTER, DARK-
                                            FIELD ILLUMINATION APH
        DIMENSIONS......................... 10X11X10 INCHES

222000 DEIONIZER, WATER                                      LS953   11111
222000
222000 PROVIDES A MEANS OF REMOVAL OF CATIONS AND ANIONS FROM WATER
222000 SUPPLIES REQUIRED FOR SPECIALIZED LABORATORY ANALYSIS
222000
222000    SOLIDS REMOVAL CAPABILITY.....<1 PPM
222000    IONS REMOVAL CAPABILITY.......<1 PPM
222000
    VWR SCIENTIFIC DIV            #24804-002/24805-005   $65          112
        CONFIGURATION ..................... PORTABLE
        TYPE .............................. DEEMINITE RESIN AND FILTERS
                                            CRYSTALAB DEMINIZER DEMINERAL-
                                            IZER
        PRODUCTIVE CAPACITY ............... 5 GALLONS/HOUR
        MINIMUM GRAIN REMOVAL ............. 1080 GRAINS AS NACL
                                            1800 GRAINS AS CACO3

    VWR SCIENTIFIC DIV            #24809-006/24809-050  $127          112
        CONFIGURATION ..................... PORTABLE
        TYPE .............................. LAB FLOW QUIKPURE DEMINERALIZER
                                            USES ION EXCHANGE RESINS
        USEABLE EXCHANGE CAPACITY ......... 1500 GRAINS TOTAL IONIC SOLIDS,
                                            CALCULATED AS NACL
        PRODUCTIVE CAPACITY ............... 60 GALLONS/HOUR
        PURITY METER ...................... 100,000 TO 10,000,000 OHMS

    CRYSTALAB                     #DF500              $125            111
        FLOW RATE.......................... 20 TO 120 GAL /HR

104180 ELECTROPHYSIOLOGY DISPLAY                             LS954   11114
104180
104180 DEDICATED DISPLAY FOR PHYSIOLOGICAL DATA TRANSMITTED BY THE
104180 ELECTROPHYSIOLOGY BACKPACK
104180
605006 ELECTROMETER                                          LS955   11111
605006
605006 MEASURE SMALL VOLTAGES AND CURRENTS FOUND IN NERVES AND MUSCLES.
605006
605006    DC VOLTAGES MEASURED..........+/-10MICROVOLTS TO +/-1VOLT
605006    DC CURRENTS MEASURED..........+/-1 PA TO +/-3 MA
605006    DRIFT.........................+/-5V/DAY AFTER 10MIN WARMUP
605006    OUTPUT.VOLTAGE................+/-10V
605006
    HEWLETT PACKARD               #425A               $695            112
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CONFIGURATION .... BENCH EQUIP
VOLTAGE RANGE .... +/- 10 MICROV TO +/- 1 V FS, 11 STEPS, 1, 3, 10 SEQUENCE
CURRENT RANGE .... +/- 10 PA TO +/- 3 MA FS, 18 STEPS, 1, 3, 10 SEQUENCE
INPUT IMPEDANCE .... 1 MEGOHM +/- 3% (VOLTAGE RANGE) 1 MEGOHM TO 0.33 OHM (CURRENT RANGE-DEPENDS ON RANGE)
ACCURACY .... < 3% OF RANGE
OUTPUT .... 0 TO 1 V FOR FS READING

ROHDE AND SCHWARZ #UIG (203.5111.02) $1120 111
VOLTAGE RANGE .... 0.2 MICROVOLT TO 320 VOLTS
CURRENT RANGE .... 0.01 MICROAMP TO 300 MA
ACCURACY .... +/- 1.5%

152500 ELECTROPHORESIS APPARATUS LS956 11111
152500
152500 SEPARATES PROTEIN AND AMINO ACID CONSTITUENTS IN SERUM,PLASMA,
152500 URINE OR SPINAL FLUID FOR QUANTITATIVE ANALYSIS.
152500
152500 VOLTAGE.......................0 TO 500 V DC
152500 SUBSTRATE.....................STARCH BLOCK, PAPER OR GEL
152500

ARTHUR H THOMAS CO #4306-810 $710 112
CONFIGURATION .... BENCH/LOOSE EQUIP
TYPE .... HORIZONTAL STRIP APPARATUS FOR PAPER, ACETATE STRIP OR GEL BLOCK ELECTROPHORESIS
CURRENT .... 0 TO 100 MA
VOLTAGE .... 0 TO 500 VOLTS

BECKMAN/SPINCO DIV #R-100 $3300-6700 112
CONFIGURATION .... BENCH/LOOSE EQUIP

BUCHLER INSTRUMENTS #27365-OCP $505 112
CONFIGURATION .... BENCH/LOOSE EQUIP
CURRENT .... 0 TO 200 MA AND 0 TO 20 MA
VOLTAGE .... 0 TO 500 VOLTS

BUCHLER #VFR 30136-001 $570 111
SAMPLE SIZE..................... 25MGS
VOLUME OF BUFFER SOLUTION....... 2 TO 10ML

178200 FREEZER, GENERAL LS957 11111
178200
178200 STORAGE OF SERUM, PLASMA, SPECIMENS AND ORGANISMS
178200
178200 OPERATING TEMPERATURE..........-4F (-20C)
178200 TEMPERATURE TOLERANCE..........+/-4F(+/-2C)
178200 STORAGE VOLUME.................4 CU. FT. (0.11CU.M.)
178200

REVCO #ULT-185A $1060 111
TEMP RANGE .... -7 TO -85 C
CAPACITY........................ 1.5 CU FT
DIMENSIONS...................... 34X24X37 INCHES
WEIGHT.......................... 270 LBS (SHIPPING)
POWER .... 115V 60 HZ 7A
CAPACITIES AVAILALBE............ 1.5 TO 17 CU FT (VAR.PRICES)

178200 FREEZER, LOW TEMP LS958 11111
178200
178200 STORAGE OF EXPERIMENT SPECIMENS
178200
178200 OPERATING TEMPERATURE..........-94F(-70C)
178200 STORAGE VOLUME.................1 CU.FT. (0.028 CU.M.)
178200

REVCO #ULT-185A $1060 111
TEMP RANGE .... -7 TO -85 C
CAPACITY........................ 1.5 CU FT
DIMENSIONS...................... 34X24X37 INCHES
WEIGHT.......................... 270 LBS (SHIPPING)
POWER .... 115V 60 HZ 7A
CAPACITIES AVAILALBE............ 1.5 TO 17 CU FT (VAR.PRICES)

048700 REFRIGERATOR LS959 11111
048700
048700 STORE SERUM AND PLASMA
048700
048700 OPERATING TEMPERATURE..........32 TO 40F(0 TO 4C)
048700 STORAGE VOLUME.................1 CU.FT. (0.0?? CU.M)
048700

MATHESON SCIENTIFIC #32035-25 $685 112
CAPACITY .... 12.8 CU FT
TEMPERATURE .... -15 TO ?7.8 C
SHIELDED AREA .... NONE
DIMENSIONS .... 32X3?X60 INCHES
EXPLOSION PROOF................. YES
COMPRESSOR .... 0.?7HP
POWER .... 115V 50-60 HZ 3.5A
WEIGHT .... 275 LBS

DILLON-LILLY #512-D $975 112
CAPACITY........................ 12.3 CU FT
TEMPERATURE .... 3.7 C
SHIELDED AREA .... NONE
DRAWERS 12
COMPRESSOR...................... 0.25 HP
POWER .... 115 V 60 HZ
WEIGHT .... 420 LBS
DIMENSIONS .... 36X56.5X28.5 INCHES

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    JORDAN                          #FT-1-AR              $1177          112
        TEMPERATURE ...................... 2.22-6.11C IN 1.11C INCR.
        CAPACITY ......................... 22.4 CU FT
        COMPRESSOR ....................... 0.25 HP
        SHIELDED AREA .................... NONE
        DRAIN ............................ NONE REQUIRED
        POWER ............................ 115V 60 HZ 6A
        DIMENSIONS........................ 78X28.5X31.625 INCHES

    BIRKEN MANUFACTURING CO         #STM-KL(DC-AC)        $335           112
        CAPACITY ......................... 8 FT**3
        VOLTAGE .......................... 115 VAC, 12, 24, 32 VDC

    FRICID CAB                      #14                   $725           112
        CAPACITY.......................... 14 CU FT
        TEMPERATURE....................... -6.7 TO +15 C
        SHIELDED AREA .................... NONE
        EXPLOSION-PROOF................... YES
        SPEARATE FREEZING COMP. .......... YES
        COMPRESSOR ....................... 0.25HP
        POWER ............................ 115V 60 HZ 3.5A
        DIMENSIONS(MAIN CHMBR)............ 26.5X20X36.5 INCHES

048700 REFRIGERATOR, RADIO ISOTOPE STORAGE                         LS960   1113-
048700
048700 STORE LIQUID AND SOLID RADIOACTIVE MATERIALS
048700
048700    OPERATING TEMPERATURE..........41+/-4F(5+/-2C)
048700    VOLUME.........................1CU.FT.(0.028CU.M.)
048700    ISOTOPES STORED................H3,C14,FE59,CR51,I131,CO45
048700
435000 GAS ANALYZER, CO2 SPECIFIC                                  LS961   11111
435000
435000 THIS DEVICE IS USED TO MONITOR ATMOSPHERIC CARBON DIOXIDE LEVELS
435000
435000    PARTIAL PRESSURE RANGE.........130 - 2700PA(1-20 MM HG)
435000
    BECKMAN INSTRUMENTS             #6501 AND 6601        $2750          111
        PARTIAL PRESSURE CO2 ............. .1 THROUGH 30 MM HG
        PARTIAL PRESSURE O2 .............. 0 TO 1000 MM HG
        POWER ............................ 12-32 VDC BAT OR EXTERNAL
        SIZE EACH UNIT ................... 6.25X4.25X3.5 INCHES
        WEIGHT (2 UNITS).................. 9 LBS
        2 UNITS CAN BE COMBINED IN 1 PKG

    INSTRUMENTATION LABORATORY      #IL 313               $5990          111
        PH ............................... 6.0 TO 9.0
        PCO2 ............................. 0 TO 200 MMHG
        PO2 .............................. 0 TO 2000 MMHG
        AUTOMATICALLY PROGRAMMED ......... YES
        SAMPLE TIME ...................... 45 SEC
        PRECISION PH ..................... +/-.003
                  PCO2 ................... +/-1MMHG
                   PO2 ................... +/-10MMHG
        SAMPLE SIZE.......................0.4ML (AUTOMATED)
        POWER ............................ 115V 50/60 HZ

    BECKMAN INSTRUMENTS INC         #CUSTOM ASSEMBLY                     114
        GASES ............................ CO, CO2, O2, N2, H2S, SO2
        SENSITIVITY ...................... 1-2 PPM FS
        AMBIENT TEMP LIMITS .............. -2 TO 120 F
        AIR REQMTS ....................... 2.5 TO 4 SCFM AT 30 PSIG

    BECKMAN INSTRUMENTS             #GC-55(577563)        $5870          111
        SENSITIVITY:
        ELECTRON CAPTURE DETECTOR......... .5 PICOGRAMS LINDANE
                                           .534 ML-MG

        THERMAL CONDUCTIVITY DET ......... 1200C DIMBAT-PROTER-STROSS
        FLAME EMISSION DET................ 10 PICOGRAMS PHOSPHORCUS
                           ............... 40 PICOGRAMS SULFUR
        OVEN TEMPERATURE ................. -99 C TO +400 C
        DIMENSIONS:
              OVEN ....................... 27.75X25.75X26.25 INCHES
              ELECTRONICS ................ 19.75X26X23 INCHES
074700 GAS CHROMATOGRAPH                                           LS962   11111
074700
074700 MEASURES CONCENTRATION OF GAS, LIQUID, AND SOLID CONSTITUENTS OF
074700 BIOLOGICAL SAMPLES
074700
074700    OPERATING TEMPERATURE..........-40 TO 752F(-40 TO 400C)
074700    CARRIER GAS....................HELIUM
074700    DETECTORS......................HYDROGEN FLAME
074700             ......................THERMAL CONDUCTIVITY
074700    FRACTION COLLECTION SYSTEM
074700
    BECKMAN                         #GC-2A                $2050          111
        DETECTOR ......................... THERMAL CONDUCTIVITY
        TEMPERATURE CONTROL RANGE ........ 40C TO 240C
        CONTROL ACCURACY ................. +/-0.1

    PERKIN-ELMER                    #3920                 $3000          111

    CARLE INSTRUMENTS, INC.         #9500                 $1185
        TEMPERATURE RANGE ................ AMBIENT TO 200 DEG C
        DETECTOR ......................... DUEL FEED SINGLE HYDROGEN FLAME
        SENSITIVITY ...................... 5E-12 AMPERES
       POWER REQUIREMENTS ................ 115 VAC, 50 TO 60 HZ

    CARLE INSTRUMENTS INC           #8001                 $675           111
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     ACCURACY ......................... +/- 0.5 PERCENT
     GASES DETECTED ................... CO, CO2, N2, AR, O2, CH4
     SAMPLE SIZE ...................... 1 PM
     REPETITIVE SAMPLING TIME ........ 5 TO 60 MIN.

 CARLE INSTRUMENTS, INC.      #AGC-311             $2675
     CONTROL SENSITIVITY ............. < 0.001 DEG C
     TEMPERATURE RANGE ............... TO 359 DEG C (1 DEG INCREMENTS)
     HEAT CAPACITY-TOTAL ............. 500 WATTS
     INLETS .......................... DUAL ON-COLUMN
     IONIZATION DETECTORS ............ HYDROGEN FLAME
     VALVING ......................... MICRO OR MINI VOLUME VALVES
     WEIGHT........................... 53 POUNDS
     POWER REQUIREMENTS .............. 115 VAC

 VARIAN AEROGRAPH             #1520                $5200          112
     COLUMN OVEN TEMP................. -99 TO 399 C
     TEMP STABILITY................... BETTER THAN .1 PER CENT
     FLAME DET SENSITIVITY............ .015 COULOMBS/GRAM
     MIN DETECTABILITY................ 5 E-12 GRAM/SEC
     NOISE............................ LESS THAN 3XE-14 A
     AMPLIFIER........................ SOLID STATE
     DIMENSIONS....................... 28X18X22 INCHES

 BECKMAN INSTRUMENTS          #6800                $7350          111
     CARRIER ......................... H2
     DETECTOR ........................ FLAME
     RANGE ........................... 0-1 PPM FULL SCALE
     ANALYSIS RATE ................... 4 TO 6/HR (SELECTABLE)
     REPEATABILITY ................... .5% OF FS
     LINEARITY ....................... 1% OF FS
     ZERO DRIFT....................... AUTOMATIC ZERO COMPENSATION
     DIMESNIONS ...................... 17X40X20 INCHES
     WEIGHT .......................... 250 LBS (SHIPPING)
     POWER ........................... 107-127V 50/60 HZ 500W

211300 GAS ANALYZER, WATER VAPOR                          LS963    11111
211300
211300 MONITOR WATER VAPOR CONTENT
211300
211300    MOISTURE RANGE..................0 TO 98% RELATIVE HUMIDITY
211300                                    (0.001 TO 20000MICROGRAMS/LITER)
211300    TEMPERATURE RANGE...............-166 TO 140F (-110 TO 60C)
211300
507900 KIT, BENCH CHEM ANAL                               LS965    11111
507900
507900 KIT CONTAINS THE TOOLS AND EQUIPMENT TO MANAGE CHEMICALS AND
507900 BIOLOGICALS DURING VARIOUS MANUAL PROCEDURES GENERALLY PERFORMED
507900 WITHIN THE GLOVE BOX.
507900
507900    TOOLS...........................SOLID TRANSPORT TOOLS.GRAVITY
507900                                    INDEPENDENT PIPETTES, VIALS,
507900                                    BOTTLES, AND TEST TUBES.
507900                                    CHEMICALS, STOPPERS, FILTERS,
507900                                    AND SAFETY SHIELDS
507900
507900 KIT, HEMATOLOGY                                    LS966    11111
507900
507900 PROVIDE TOOLS FOR SAMPLING, HANDLING, TRANSFERRING AND ANALYZING
507900 BLOOD
507900
507900    ITEMS...........................HEMATOMETER KIT; 10 LAMBDA
507900                                    DISPOPIPETTES; COVERSLIPS;
507900                                    SLIDES; WBC AND RBC DILUENT;
507900                                    CRITOSEAL; HEMOCRIT TUBES(MICRO,
507900                                    HEPARINIZED); HEMOCRIT TUBES
507900                                    (MICRO, PLAIN); BLOOD DILUTING
507900                                    PIPETTES (WBC, RBC); COMBISTIX
507900                                    (URINE TEST STRIPS); LUER
507900                                    ADAPTERS, VACUTAINER; VACUTAINER
507900                                    VACUTAINER-NEEDLE UNIT;
507900                                    VACUTAINER TUBES, ASSORTED(2ML);
507900                                    SYRINGE (LARGE), PEDIATRIC
507900                                    ALCOHOL SWABS; LANCETS; NEEDLE,
507900                                    25GA, 5/8IN; NEEDLE 22GA,1 1/2IN
507900
507900 KIT, LINEAR MEASUREMENT                            LS967    11111
507900
507900 DETERMINE SIZE, AMPLITUDE, DISTANCE, CIRCUMFERENCE,ETC
507900
507900 ITEMS..............................RULERS; TAPES; LINEAR COPARATOR;
507900                                    GRIDS; CALIPERS, INSIDE AND
507900                                    OUTSIDE; VERNIER CALIPERS;
507900                                    MICROMETERS, INSIDE AND OUTSIDE
507900
507900 KIT, MICROBIOLOGY                                  LS968    11111
507900
507900 PROVIDE TOOLS TO FACILITATE GROWING AND ANALYZING MICROBIAL
507900 ORGANIZIMS
507900
507900 ITEMS..............................INOCULATING LOOP; INOCULATING
507900                                    NEEDLE; COTTON SWABS, PACKAGES,
507900                                    STERILE; SYRINGE 5ML, STERILE;
507900                                    SLIDES, MICRO; ALCOHOL; TUBES,
507900                                    15X75MM, STERILE, CAPPED;
507900                                    ZEPHIRAN, TINCTURE, 1:500;
507900                                    BACTECINERATOR(STERILIZING UNIT)
507900                                    ; THIOGLYCOLLATE, TUBED; STUART
507900                                    TRANSPORT MEDIA, VIALS; TSA
507900                                    SLANTS
507900
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    LKB INSTRUMENTS INC.            #8815 ACCESS. KIT I             111
        SPECIMEN HOLDERS ................ 6
        SYRINGE ......................... 2 ML
    LKB INSTRUMENTS INC.            #8816 ACCESS. KIT II            111

507900 KIT, ORGANISM HOLDING AND MANAGEMENT              LS969   11111
507900
507900 PROVIDE TOOLS AND DEVICES USED IN THE HOLDING AND HANDLING OF THE
507900 ORGANISMS
507900
507900 ITEMS FOR SMALL VERTEBRATES......GLOVE POWDER; CAGE SHIELD,
507900                                  PLASTIC; PLASTIC LINER WITH PAD;
507900                                  FOOD PELLET DISPENSER; ALCOHOL
507900                                  SWABS; TOWELS, PAPER, DISPC.;
507900                                  PLASTIC BAG(FOR EXPENDIBLES);
507900                                  PLASTIC BAG(FOR NONEXPENDIBLES);
507900                                  ORGANISM TRANSFER CAPSULE;
507900                                  ANIMAL TAGS
507900    ITEMS FOR PLANTS..............WATERING DEVICE(SPRAY BOTTLE);
507900                                  LABELS; FERTILIZER PACKETS;
507900                                  STAKES(10CM)
507900
507900 KIT, PLANT TOOLS                                  LS970   11111
507900
507900 PROVIDE TOOLS FOR VARIOUS PLANT MANIPULATIONS
507900
507900    ITEMS.........................SCISSORS, TWEEZERS, SPATULA,
507900                                  APPLICATOR, SPLINTS, TAPE
507900                                  DISPENSER, HYPODERMIC NEEDLES,
507900                                  SYRINGES, FORCEPS, PLIERS,
507900                                  SCREWDRIVER, SCALPELS, SEALERS
507900
507900 KIT, GENERAL TOOL                                 LS971   11111
507900
507900 MECHANICAL AND ELECTRICAL TOOLS AND HARDWARE TO PROVIDE
507900 CONVENTIONAL DIAGNOSTIC, MAINTENANCE, AND SERVICE FUNCTIONS.
507900
507900    TOOLS.........................HAMMER, WRENCHES, PLIERS, SCREW
507900                                  DRIVERS, DRILL, ADHESIVE TAPE,
507900                                  WIRE CUTTERS, WIRE TIES, WIRE,
507900                                  LUBRICANTS, FLASHLIGHT, SCISSORS
507900                                  , MULTIMETER, FASTENERS, CLAMPS,
507900                                  LAMP
507900
    LABORATORY SPECIALISTS LTS     #1662             $140           112
        TOOLS.......................... 33 SELECTED TOOLS INCLUDING
                                          WRENCHES,PLIERS,TAPPING TOOL,
                                          SCREW DRIVERS,NUT DRIVERS,
                                          RIVETS,TERMINALS,ETC
        CASE........................... 19X14X5.5 INCHES
235700 LYOPHILIZER                                       LS972   11111
235700
235700 PROVIDE FREEZE DRYING OF SMALL SPECIMENS
235700
235700    SAMPLE CAPACITY...............20-1CU.IN.(16CC)
235700    TEMPERATURE RANGE.............-40F TO 252F(-40 TO 122C)
235700
    SCINTIFIC PRODUCTS DIV         #D7C27-5          $1390          111
        CONFIGURATION .................. BENCH EQUIP
        TYPE ........................... FRONT LOADING, SINGLE SHELF
        TEMPERATURE RANGE .............. -40 TO 122 C (-40 TO 250 F)

    VIRTIS                         #UNITRAP          $1300          111
        TEMPERATURE(MIN)................-65F(-55C)
        DRUM SIZE....................... 8IN(21CM)DIA.X10IN(25.4CM) HIGH
        CONFIGURATION................... FLOOR MOUNT, PORTABLE
        VACUUM PUMP NOT INCLUDED

    SARGENT WELCH SCIENTIFIC CO.  #S-28881-80        $3510          111
        LOW TEMPERATURE ................ -65F
        CAPACITY ....................... 12 LITERS
        VACUUM ......................... 5 MICRONS
        PUMP CAPACITY .................. 140 LITERS/MIN.

023500 MASS MEASUREMENT DEVICE, MACRO                    LS973   11132
023500
023500 MEASURE MASS OF ITEMS SUCH AS BAGS OF FOOD, BEVERAGE CONTAINERS,
023500 CONTAINERS OF URINE AND FECES, LARGE SPECIMENS, ETC
023500
023500    MASS RANGE....................C.22 TO 66LB (0.1 TO 30KG)
023500
    SOUTHWEST RESEARCH INSTITUTE  #074 (SKYLAB)                     511
        SPECIMEN MASS MEASURING DEVICE
        ELEMENTS OF ASSEMBLY ........... SPECIMEN TRAY SUPPORTED ON
                                           PLATE-FULCRA SPRINGS, PERIOD/
                                           TEMPERATURE MEASURING ELEC-
                                           TRONIC SUBSYSTEM
023500 MASS MEASUREMENT DEVICE, MICRO                    LS974   11132
023500
023500 MEASURE SMALL TEST SPECIMENS
023500
023500    MASS MEASUREMENT RANGE........1MG TO 100 G
023500
396480 OPTISCAN-FIELD AND FIXATION POINT RECORDER        LS975   11111
396480
396480 THIS  INSTRUMENT  PERMITS  THE RECORDING OF THE VISUAL FIELD AS
396480 THE SUBJECT'S FIXATION WITHIN THE FIELD WITHOUT RESTRICTION OF
396480 HEAD MOVEMENTS
396480
396480    ACCURACY......................2DEG OF ARC
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396480
004400 CATALYTIC OXIDIZFR SYSTEM                               LS977   11235
004400
004400 REMOVES UNDESIRABLE COMPUSTION PRODUCTS
004400
004400    OPERATING TEMPERATURE..........70CF(370C)
004400    AIR FLOW RATE..................2CFM AT 14.7PSIA AND 70F
004400
048050 BLOOD PRESSURE CUFF SYSTEM                              LS978   11132
048050
048050 PRESSURE MEASURING TRANSDUCER CUFF USED TO MEASURE BLCCD PRESSURE
048050 OF PRIMATES.  SYSTEM INCLUDES AIR PUMP FOR AUTOMATED MEASURING.
04805C PRESSURE CUP AND TRANSDUCER, AND SIGNAL CONDITIONER.
C48050
   MARTIN CO                     #M092-BPMS  (SKYLAB)                   511
        CUFF VOLUME ..................... 20 CU.IN.
        BPMS MAX OPERATING PRESSURE .... 210  PSIG
        BPMS MIN OPERATING PRESSURE .... 90 PSIG
        BPMS BURST PRESSURE ............ 5000 PSIG
        BPMS MAX OVERPRESSURE .......... 235 PSIG
        CUFF MAX OPERATING PRESSURE .... 250 MM HG
        CUFF RELIEF PRESSURE ........... 260 MM HG
        GAS TEMPERATURE ................ 40 TO 120F

619011 RADIATION SOURCE STORAGE                                LS979   11112
619011
619011 STORAGE FACILITY FOR RADIOACTIVE MATERIAL.
619011
619011    VOLUME APPROXIMATELY .......... 1 CU FT
619011    RADIATION PROTECTION LIMIT ... UP TC 500 MICROCURIES
619011
618016 RECEIVER - BIOTELEMETRY                                 LS980   11111
618016
618016 RECEPTION OF BIOTELEMETRY SIGNALS FROM DEEP BODY TEMPERATURE AND
618016 ANIMAL ACTIVITY AS WELL AS FOR ELECTROMAGNETIC FIELD MCNITCRING.
618016
618016    FREQUENCY RANGE ............... TO 5 MHZ
618016    SENSITIVITY ................... 0.5 MV FOR 20 DB QUIETING
618016    TUNING ........................ VARIABLE AND CRYSTAL CCNTRCLLED
618016
   HEWLETT PACKARD               #781O1A              $800              112
        CONFIGURATION .................. BENCH EQUIP
        FREQUENCY RESPONSE ............. 0.1 TO 1000 HZ
        SENSITIVITY .................... 0.5 MICRO-V
        ANTENNA ........................ 7 INCH MONOPOLE
        INPUT IMPEDANCE ................ 50 OHMS NOMINAL

039648 VISION TESTER                                           LS981   11235
039648
039648 OPTICAL DEVICE (WITH HOOD AND RESPONSE KEYBOARD) THAT MEASURES
039648 A VARIETY OF VISUAL FUNCTIONS.
039648
338000 WASTE STORAGE SYSTEM                                    LS982   11111
338000
338000 PROVIDE FOR HANDLING, STORAGE AND DISPOSAL OF SOLID AND LIQUID
338000 WASTE MATTER FROM THE EXPERIMENTS.
338000
338000    CAPACITY ...................... 5 CU FT
338000
470500 STERILIZER - TOOL                                       LS983   11111
470500
470500 STERILIZE MISCELLANEOUS SMALL METAL HAND TOOLS SUCH AS SCALPELS,
470500 BY MEANS OF ELECTRICAL INDUCTION HEATING.
470500
470500    CAPACITY ...................... 0.1 CU FT
470500
    VWR SCIENTIFIC                #58615-CC7          $255
        OPERATING TEMPERATURE.............200C (MAX)
        SHELF SIZE........................18X10X1/2  (3)
        CHAMBER SIZE......................18X8X10
        POWER.............................115 VAC, 50/60 HZ, 7.5 A
                                          900 W
034930 AUDIO STEREO HEADSET                                    LS985
034930
034930 EARPHONES FOR VARIOUS MSI HEARING TESTS
034930
173000 FLOW METER, WATER MANIFOLD                              LS989   11235
173000
173000 IN LINE MEASUREMENT OF WATER FLOW, GENERALLY A LOW RATE
173000 ASSOCIATED WITH WATER CONSUMPTION BY ORGANISMS
173000
172500 FLOW METER, GAS                                         LS992   11111
172500
172500 MEASURE AIR FLOW
172500
401000 IMPEDANCE PNEUMOGRAPH                                   LS995   11111
401000
401000 MEASURE BREATHING CYCLE CHARACTERISTICS
401000
    TECHNOLOGY/VERSATRONICS INC   #MFG-3              $970              111
        OUTPUT(SINGLE ENDED) ............ 0-5VDC LINEAR IN MASS FLOW
        OUTPUT IMPEDANCE ................ <10 OHM
        ACCURACY(ABSOLUTE) .............. +/- 2% OF READING 20 TC 100% FS
                                          +/- 20MV FROM 0 TO 20% FS
        LINEARITY ........................+/- 0.4% FULL SCALE (FS)
        REPEATABILITY ................... +/- C.1% FO READING
        CALIBRATION PRESSURE ............ 1 ATMOSPHERE
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        STD CALIBRATION TEMP RANGE ...... 55 TO 155F
        MEDIUM .......................... AIR
        TIME CONSTANT ................... LESS THAN 0.07 SEC
        PRESSURE DROP ................... LESS THAN 1 IN H2O
        READOUT ......................... 18 TAUT BAND MIRROR SCALE
                                          0-100% FLOW RATE
        AVAILABLE RANGE ................. 0.12 TO 0.6 CU FT PER MIN
        SIGNAL CONDITIONER .............. 0 TO 40F
        TRANSDUCER ...................... -45 TO 150F

507900 KIT, CLEAN UP                                           LS999   11111
507900
507900 GENERAL PURPOSE CLEAN UP - SPONGES AND WIPES
507900
507900 KIT, MEDICAL SURGICAL                                   LS1000  11111
507900
507900 FOR VARIOUS MINOR SURGICAL PROCEDURES
507900
507900 KIT, PHYSIOLOGY                                         LS1001  11111
507900
507900 SPONGES, SPONGE SQUEEZER, VIALS, CALORIC STIMULATOR FOR EAR
507900 CANAL, SYRINGES, THERMOETERS, ETC.
507900
507900 KIT,TOOL - INSECT MANIPULATION                          LS1002  11111
507900
507900 TOOL KIT FOR COUNTING, SORTING, EXAMINATION,ETC.
507900
256000 MICROPHONE                                              LS1007  11111
256000
256000 MICROPHONES USED FOR BIOLOGY, BIOMEDICINE AND MANNED SYSTEMS
256000 INTEGRATION
256000
006170 MICROPHONE AMPLIFIER                                    LS1008  11111
006170
006170 AMPLIFY SIGNALS FROM AMPLIFIER
006170
484000 MONITOR, VIDEO                                          LS1009  11111
484000
484000 MONITOR TV PICTURES OF ANIMAL AND OTHER LAB ACTIVITIES
484000
    COHU ELECTRONICS INC.          #CQF                  $775          111
        BANDWIDTH ....................... 30 MHZ
        HORIZONTAL LINES ................ 1225
        FIELDS .......................... 60/SEC.

    CONRAC CORPORATION             #RQA 14/R             $1620         111
        VIDEO AMPLIFIER
            COMPOSITE ................... 0.3 - 3.0 V P-P
            NONCOMPOSITE ................ 0.3 V P-P FOR 100 PCT CONTRAST
                                          3.0 V P-P MAXIMUM BEFORE PREAMP
                                          OVERLOAD
        VIDEO INPUT IMPEDANCE ........... 50 K OHM MIN SHUNTED BY MAX 10
                                          PFD SIGNAL OF 20 V P-P; HUM
                                          SUPPRESSION 40 DB 60-1000 HZ
        VIDEO FREQUENCY RESPONSE
            AT 50 PCT OF MODULATION .... FLAT +/- 1 DB  TO 30 MHZ, -6 DB
                                          AT 40 MHZ
            AT 30 PCT OF DEPTH MOD ..... FLAT +/- 1 DB  TO 30 MHZ, -2 DB
                                          AT 40 MHZ
        PULSE RESPONSE .................. LESS THAN 15 NS RISE/FALL TIME
                                          AT 50 PCT DEPTH OF MODULATION
        EXTERNAL SYNC ................... COMPOSITE OR SEPARATE H/V SYNC:
                                          0.5 V TO 10 V P-P, GREATER THAN
                                          5K OHM INPUT IMPEDANCE
        LINEARITY ....................... +/- 1 PCT PICTURE HEIGTH
        RETRACE TIME
            HORIZONTAL .................. 5 MICROSEC MAX
            VERTICAL .................... 800 MICROSEC MAX
        SCANNING FREQUENCY
            HORIZONTAL .................. 15 - 40 KHZ
            VERTICAL .................... 15 - 60 FIELDS/SECOND

    COHU INC. ELECTRONICS DIV      #960C                 $5260
        PICTURE SIZE .................... 7-3/16W X 5-3/8H INCHES
        HORIZONTAL SCAN ................. 945 LINES, 50 OR 60 FIELDS/SEC
                        ................. 875 LINES, 60 FIELDS/SEC
        VIDEO BANDWIDTH ................. 20 MHZ +/- 2 DB
        POWER ........................... 25-28.5 VDC, 150 WATTS

419500 PUMP GAS, CIRCULATING                                   LS1011  11111
419500
419500 PUMP FOR SEALED PLANT GROWTH CHAMBER
419500
498200 TIMER, EVENT                                            LS1020  11111
498200
498200 GENERAL PURPOSE ELAPSED TIME DEVICE USED FOR VARIOUS PSYCHOMOTOR
498200 TESTS
498200
    ROHDE AND SCHWARZ              #CAD (100.6597.91)    $5400         111
        DISPLAY ......................... 6 DIGITS: HR, MIN, SEC
        OUTPUT .......................... 1-OUT-OF-N AND/OR BCD CODE
        PROGRAMMER.......................TIME PROGRAMS(COUNT
                                          DOWN) AND TIME SIGNALS

    CATATRON                       #3350-506             $1170         111
        INPUT FREQUENCY.................. 60HZ
        OUTPUTS.......................... VISUAL,BCD
        DISPLAY.......................... HRS,MIN,SEC
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    TENNELEC                           #TC545                   $550        111
         COUNT RATE....................... 20MHZ
         TIMEBASE......................... 0.1 OR 0.01SEC
         ACCURACY......................... SAME AS LINE FREQUENCY
         CONFIGURATION.................... NIM COMPATIBLE
043500 CARDIOGRAPH - IMPEDANCE                                    LS100   11111
043500
043500 BLOOD FLOW RATE FROM HEART.
043500
043500    BLOOD FLOW RATE ............... 2 TO 25 LITERS/MIN +/-5 PCT FS
043500
    MARTIN CO  .                       #M093 (SKYLAB)                       511
         MEASURES ELECTROCARDIOGRAPHIC POTENTIALS OF EACH ASTRONAUT

143500 ECG/VCG                                                    LS101   31131
143500
143500 MONITOR HEART CONDITION.  ELECTRO/VECTORCARDIOGRAPH.
143500
143500    SENSITIVITY ................... 0 TO 3 MV +/-1 PCT FS
143500    HEART RATE .................... 40 TO 180 BEATS/MIN
143500
    TEKTRONIX INC                      #410                     $575        111
         BANDWIDTH ...................... 0.1 HZ TO 100 HZ (+/- 15%)
         SENSITIVITY .................... 10 MM/50 MICROVOLT (+/-5%)
                                          AUX MODE 2 MM/MV (+/- 5%)
         DISPLAY ........................ 5 INCH CRT

144500 EEG - ELECTROENCEPHOLOGRAPH                                LS102   11131
144500
144500 MONITOR ELECTRICAL IMPULSES GENERATED BY THE BRAIN.
144500
144500    SENSITIVITY ................... 10 TO 200 MICROVOLTS +/-1 PCTFS
144500    FREQUENCY RESPONSE ............ 0.2 TO 100 HZ
144500    CHANNELS ...................... 6
144500
    BECKMAN INSTRUMENTS                #9852A(COUPLER ONLY      $95         111
         COUPLER USED WITH 425500
         FREQUENCY ...................... 10 TO 200 HZ
         PULSE DURATION ................. .6 MS TO 20 MS
         SKIN ELECTRODES ................ REQUIRED

    TEKTRONIX INC                      #410-3                   $1025       111
         BANDWIDTH ...................... 0.1 HZ TO 100 HZ (+/- 15%)
         SENSITIVITY .................... 10 MM/50 MICROVOLT (+1/5%)
                                          AUX MODE 2 MM/MV (+/- 5%)
         DISPLAY ........................ 5 INCH CRT

    BECKMAN INSTRUMENTS                #ACCUTRACE               $5850       112
         SENSITIVITY .................... 0.5 MICROVOLTS/MM (MAX)
         SENSITIVITY MASTER CONTROL ..... 2,3,5,7.5,10,15,20,30,50,75MUV
         SENSITIVITY MULTIPLIER CONTROLS. X20,4,2,1,.5,.25
         FREQUENCY RESPONSE ............. DC TO 70 HZ
         CHANNELS ....................... 8 PLUS TWO EVENT CHANNELS
         WEIGHT ......................... 150 LBS
         DIMENSIONS ..................... 35X23X21 INCHES
         POWER .......................... 105-130V 60 HZ 50W

    BECKMAN INSTRUMENTS                #TYPE T PORTABLE         $6630       112
         SENSITIVITY .................... 1 TO 100 MICROVOLTS/MM
         FREQUENCY RESPONSE ............. DC TO 150 HZ
         CHANNELS ....................... 8
         WEIGHT ......................... 86 LBS
         POWER .......................... 115V 60 HZ 50W AND 6 D CELLS
         DIMENSIONS ..................... 17X19X10.5 INCHES(EACH OF 2 PCS

142000 DYNAMOMETER                                                LS103   11133
142000
142000 MEASUREMENT OF FORCE OR POWER.
142000
142000    ARM FLEXION ................... 25 TO 75 LB (10 TO 35 KG)
142000    BACK EXTENSION ................ 100 TO 200 LB (40 TO 90 KG)
142000
145500 EMG - ELECTROMYOGRAM                                       LS104   11131
145500
145500 MONITOR THE MOVEMENT OF THE BODY MUSCULAR SYSTEM.
145500
145500    SENSITIVITY ................... 0.01 TO 5 MV +/-1 PCT FS
145500    BANDWIDTHS .................... 0.5 TO 200 HZ, 0.5 TO 1000 HZ
145500    CHANNELS ...................... 1
145500
143500 PHONOCARDIOGRAM                                            LS106   11111
143500
143500 AURAL MONITOR OF HEART BEAT.
143500
143500    SENSITIVITY ................... 0.1 TO 1000 HZ, +/-5 PCT FS
143500
       BECKMAN INSTRUMENTS             #98C2 COUPLER ONLY       $35         111
        COUPLER USED WITH 425500
        FREQUENCY ....................... 5 TO 2000 HZ
        ABOVE 200 HZ .................... REQUIRES SCOPE OR TAPE READOUT
        TRASDUCERS ...................... REQUIRED

052570 METABOLIC ANALYZER                                         LS1003  11131
052570
052570 MEASURE O2 CONSUMPTION, CO2 PRODUCTION, MAXIMAL O2 CONSUMPTION
052570 AND ALVEOLAR PO2 AND PCO2.
052570
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092970    O2 VOLUME ......................... 0 TO 40 L/MIN, +/-3 PCT FS
092970    CO2 VOLUME ........................ 0 TO 40 L/MIN, +/-3 PCT FS
092970    ALVEOLAR O2 ....................... 20 TO 120 MM HG +/-2 PCT FS
092970    ALVEOLAR CO2 ...................... 20 TO 70 MM HG +/-2 PCT FS
092970
     MARTIN CO                          #M171 (SKYLAB)                    511
        MEASURE METABOLIC ACTIVITY
        PARAMETERS MEASURED.............. OXYEN CONSUMPTION
                           .............. CARBON DIOXIDE
                           ...............RESPIRATORY EXCHANGE RATIO
                           .............. MINUTE VOLUME
                           .............. VITAL CAPACITY
                           .............. BODY TEMPERATURE
                           .............. ERGOMETER WORK RATE, RPM AND
                                           TOTAL WORK
        COMPONENTS OF ASSEMBLY .......... MASS SPECTROMETER
                               .......... GAS ANALYZER
                               .......... ANALOG COMPUTER
                               .......... INSPIRATION AND EXPIRATION
                                           SPIROMETERS
                               .......... CO2 STABILIZER
                               .......... CALIBRATION GAS SUPPLY

     PERKIN ELMER CORP         .        #NAS 9-2255          $45000       511
        TYPE ............................ SOLID STATE
        CO2 RANGE ....................... 130 TO 4000 PA (1-30 MM HG)
        OUTPUT VOLTAGE .................. 0 - 5 VDC
        OUTPUT IMPEDANCE ................ < 500 OHMS

     BECKMAN INSTRUMENTS                #554103              $15800       111
        SENSITIVITY O2................... 100% FS
                    CO2.................. 10% FS
        ACCURACY  O2 .................... +/-.2 FS
                 CO2..................... +/-1 % FS
        RESPONSE (MSEC) O2 .............. 90% AT 500ML/MIN
                        CO2 ............. 90% AT 100ML/MIN
        METER READOUT ................... DIGITAL
        RESOLUTION (% GAS)............... .01%(CO2).1%(O2)
        MEASURE ALVEOLAR O2.............. YES
        MEASURE ALVEOLAR CO2............. YES
        CHART SPEED ..................... 1MM/S:10MM/S
        WRITING METHOD................... HEATED STYLUS
        WEIGHT .......................... 270 LBS (122.5 KG)

043500 PULMONARY FLOWMETER                                    LS990   11131
043500
043500 BLOOD FLOW RATES AND VOLUME.
043500
043500    FLOW RATE ..................... 0 TO 15 L/MIN, +/-3 PCT FS
043500    VOLUME ........................ 0 TO 7 L, +/-3 PCT FS
043500
043500 TRANSCUTANEOUS DOPPLER FLOWMETER                       LS991   11112
043500
043500 MEASURE PULSE WAVE CONTOUR.
043500
043500    ULTRASONIC SIGNAL ............. 1 AND 5 MHZ
043500
048000 PULSE WAVE                                             LS112   11112
048000
048000 MEASURE BLOOD VELOCITY
048000
048000    VELOCITY ...................... 3 TO 15 M/S, +/-0.1 M/S
048000
     BECKMAN INSTRUMENTS INC       #                    $4000           111

199400 ERGOMETER - BICYCLE                                    LS986   11131
199400
199400 WORKLOAD MEASURING DEVICE.
199400
199400    LOAD RANGE .................... 0 TO 300 WATTS, +/-2 PCT FS
199400    ROTATIONAL SPEED .............. 40 TO 90 RPM
199400
187110 LITTER CHAIR - ROTATING                                LS114   11131
187110
187110 GRAVITY INDUCING DEVICE AND HORIZONTAL WORK TABLE.
187110
187110    ROTATION SPEED ................ 0 TO 60 RPM
187110
612015 LBNP - LOWER BODY NEGATIVE PRESSURE                    LS115   11131
612015
612015 MEASURE INTERNAL BODY PRESSURE DIFFERENTIAL.
612015
612015    PRESSURE DIFFERENTIAL ......... 50 MM HG BELOW CABIN AMBIENT
612015
     MARTIN CO                          #M092-LBNPD (SKYLAB)              511
        VOLUME(INTERNAL) ................ 10 CU.FT
        OPERATING TEMPERATURE RANGE ..... 67 TO 78F
        MAX NEGATIVE PRES BELOW AMBIENT   50 MM HG
        LEAKAGE ......................... 2.5 CU.FT./MIN MAX

199310 EXERCISER/ERGOMETER - PRIMATE                          LS175   11133
199310
199310 PRIMATE EXERCISER AND WORKLOAD MEASURING DEVICE.
199310
603009 CALORIMETRY MODULE - PRIMATE                           LS964   11135
603009
603009 PORTABLE AND COLAPSABLE UNIT WHICH HOUSES, FEEDS, AND ANALYZES
603009 THE PRIMATE SPECIMEN WITHIN.
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603009
603009    PO2 ......................... 160 +/-10 MM HG
603009    PN2 ......................... 580 +/-20 MM HG
603009    PCO2 ........................ 6 MM HG OR LESS
603009    PH2O ........................ 12 +/-3 MM HG
603009    TEMPERATURE ................. 77 +/-4 F   (25 +/-2 C)
603009
023500 MASS MEASUREMENT DEVICE - BODY                      LS987   11131
023500
023500 TOTAL BODY MASS DETERMINATION BY OSCILLATING FREQUENCY.
023500
023500    MASS ........................ 125 TO 230 LB,+/-0.1 PCT FS
023500                                  (50 TO 100 KG)
023500
   SOUTHWEST RESEARCH INSTITUTE  #M172 (SKYLAB)                    511
      ELEMENTS OF ASSEMBLY ........... SEAT, SPRING LOADING SYSTEM
                                       AN ELECTRONIC SUBSYSTEM MODULE

229600 LIGHTING SYSTEM - PLANT                             LS1018   21114
229600
229600 PROVISIONS FOR LIGHT PLANT GROWING AREAS.
229600
229600    TYPE LIGHT .................. DAYLIGHT-FLUORESCENT
229600    ILLUMINATION ................ 102 FT-C (1100 LUM/M2)
229600
384000 PLANT GROWTH AND SUPPORT CONTAINERS                 LS1019  121111
384000
384000 VARIOUS SIZE CONTAINER TO ENVIRONMENTLY HOUSE SEEDLINGS.
384000
384000    CAPACITY .................... UP TO 20-CM PLANTS
384000
217500 CELLS/TISSUE HOLDING UNIT                           LS1016  121114
217500
217500 COMBINATION HOLDING UNIT/INCUBATOR CONTAINING ELECTRONIC PLUG-IN
217500 CAPABILITY FOR MEASUREMENT DEVICES
217500
217500    TEMPERATURE RANGE ........... 41 TO 140 F   (5 TO 60 C)
217500    PCO2 ........................ 160 +/-5 MM
217500    PN2 ......................... 600 +/-20 MM
217500    PCO2 ........................ 3 MM OR LESS
217500    TOTAL PRESSURE .............. 760 +/-20 MM
217500    RELATIVE HUMIDITY ........... 60 TO 100 PCT
217500
229600 CELLS/TISSUE HOLDING UNIT LIGHTING                  LS1017   21114
229600
229600 PROVISION FOR PROVIDING COOL DIFFUSED LIGHT
229600
229600    ILLUMINATION ................ 90 +/-10 FT-C
229600    TEMPERATURE ................. AMBIENT
229600
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      SPACE TECHNOLOGY

603013 CONDENSER                                            ST102    11131
603013
603013 DEVICE TO CONDENSE STEAM IN ZERO GRAVITY
603013
410000 CONDENSATE TANKS                                     ST102    21113
410000
410000 TANKS FOR STORAGE OF CONDENSATE
410000
410000     PRESSURE..................... 20PSI (1.38X10E5 N/M**2)
410000
104000 SUPPORT ELECTRONICS                                  ST006    21114
104000
104000 ELECTRONICS SUPPORT COMMUNICATIONS EXPERIMENTS INCLUDING
104000 MULTIPLEXERS WITH CONVERTERS AND OSCILLATORS
104000
398500 OSCILLOSCOPE                                         ST007    21111
398500
398500 MONITOR, MEASURE AND MAINTAIN ELECTRONIC EQUIPMENT OPERATING IN
398500 THE L-BAND RANGE (390 TO 1550 MHZ).
398500
398500     BANDWIDTH .................... 390 TO 1550 MHZ
398500     CHANNELS ............................ 2
398500     DEFLECTION FACTOR ............ 10 MV/DIVISION
398500     PHOTOGRAPHIC CAPABILITY .............. YES
398500
    TEKRONIX INC                  #R564B/3A6 PLUG-IN/  $2340         111
                                   3B4 PLUG-IN
        BANDWIDTH ....................... DC TO 10 MHZ
        CHANNELS ........................ 2
        DEFLECTION FACTOR ............... 10 MV/DIV TO 10 V/DIV
        TIME BASE ....................... 50 NS/DIV TO 5 S/DIV
        MAX VIEWING TIME ................ 1 HOUR
        MAX STORED WRITING SPEED ........ 500 DIV/MS
        TYPE OF STORAGE ................. SPLIT SCREEN BISTABLE

    TEKTRONIX                     #DM64                $1095         111
        BANDWIDTH ....................... DC TO 10 MHZ
        RISETIME ........................ 35 NS
        SPEED WRITING ................... 25 CM/MS (NOMINAL)
                                          250 CM/MS (ENHANCED MODE)
        STORAGE VIDEO TIME .............. 1 HR
        ERASE TIME ...................... 0.25 S
        DEFLECTION FACTOR ............... 10 MV/CM TO 50 V/CM IN 12 STEPS
        TIME BASE ....................... 100 NS/CM TO 2 S/CM IN 23 STEPS
        RESPONCE TIME....................LESS THAN 1 NS

    HEWLETT-PACKARD               #132A                $1500         111
        BANDWIDTH ....................... DC TO 500KHZ
        SENSITIVITY ..................... 100 MICROVOLTS/CM
        INDEPENDENT BEAMS ............... 2
        WEIGHT .......... ............... 43 POUNDS

    TEKTRONIX INC                 #R465                $1800         111
        BANDWIDTH ....................... DC TO 100 MHZ
        CHANNELS ........................ 2
        DEFLECTION FACTOR ............... 5 MV/DIV TO 5 V/DIV
        TIME BASE ....................... 0.01 MICROSEC/DIV TO 0.5 S/DIV
    TEKTRONIX                     #485                $4200          111
        RANGE,CALIBRATED................  5MV/DIV TO 5V/DIV IN 10 STEPS
              UNCALIBRATED............... CONT VAR TO 12.5V/DIV
        RESPONSE TIME....................LESS THAN 1 NS
        CHANNELS......................... 1,ALTERNATE, CHOPPED,ADDED,X-Y
             ............................ CHANNEL 2 (+UP OR INVERTED)
        DIMENSIONS....................... 16.7 X 52.4 X 30.5 CM
        WEIGHT........................... 9.5 KG
        POWER............................ 115/230V 48-440HZ  60W

    TEKTRONIX INC                 #R561B/3A6 PLUG-IN/  $1840         111
                                   3B4 PLUG-IN
        FREQUENCY BANDWIDTH ............. DC TO 10 MHZ
        CHANNELS ........................ 2
        DEFLECTION FACTOR ............... 10 MV/DIV TO 10 V/DIV
        TIME BASE ....................... 50 NS/DIV TO 5 S/DIV
        RISETIME ........................ 35 NS

424000 TAPE RECORDER, DIGITAL                               ST008    21111
424000
424000 RECORD AND PLAYBACK OF DIGITAL DATA IN SUPPORT OF MICROWAVE
424000 INTERFEROMETER AND TRACKING INVESTIGATIONS.
424000
424000     SIGNAL TYPE .................. 0 TO 5 VDC
424000     BANDWITH ..................... 100 TO 250 KHZ
424000     CHANNELS ..................... 4 (MINIMUM)
424000     DATA REQUIREMENT ............. 2 HRS (MINIMUM)
424000
    AMPEX CORPORATION             #AR-200                            121

        BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                          300 HZ TO 250 KHZ
        TAPE WIDTH ...................... 0.5 INCH
        TAPE SPEED ...................... 1.875 TO 60 IPS
        RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
        FORMAT .......................... DIGITAL
        TRACKS .......................... 8 DIGITAL, 7 ANALOG

    AMPEX CORP                    #AR 1700            $28,000        112
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    TRACKS ........................... 14
    TAPE SPEED ....................... 120 IPS
    TAPE WIDTH ....................... 1 INCH
    RECORDING MODE.................... DIRECT
    PACKING DENSITY .................. 20 KB/I/T
    SIGNAL/NOISE ..................... 20 DB
    DATA CAPACITY .................... 6.2E+10
    BANDWIDTH ........................ 2 MB/SEC/T

SANGAMO ELECTRIC          #SABER III          $26,500        111
    TRACKS ........................... 14
    TAPE WIDTH ....................... 1 INCH
    TAPE SPEEDS....................... 8 SELECTABLE SPEEDS FROM 15/16
                                       TO 120 IPS
    FREQUENCY RESPONSE ............... 400 HZ TO 2.0 MHZ
    RECORDING RATE ................... 600 KBPS AT 120 IPS SERIAL MODE
    WEIGHT ........................... 100 POUNDS

DIGI-DATA CORPORATION     #1600                $2650         111
    TAPE SPEED ....................... 25, 18.75, 12.5 IPS
    TRACKS ........................... 7 OR 9 TRACK
    DATA DENSITY ..................... 1600 CPI PHASE ENCODED
                                       200, 556, 800 CPI NRZI
    TAPE ............................. 0.5 INCH, 1.5 MIL, 1200 FEET

DIGI-DATA CORPORATION     #1700/PDP-11/7-9     $5250         111
                            TRACK NRZI
    TAPE SPEED ....................... 45, 37.5, 25, 18.75, 12.5 IPS
    TAPE ............................. 0.5 INCH, 1.5 MIL, IBM/ANSI
                                       COMPATIBLE, 10.5 INCH REEL
    TRACKS ........................... 7 OR 9
    DATA DENSITY ..................... PHASE ENCODED
                                       COMPATIBLE

HEWLETT PACKARD           #7970B/C             $ 4600        111
    TAPE FORMAT ...................... 800, 556, OR 200 CPI NRZI AND
                                       1600 CPI PHASE-ENCODED
    CHANNELS ......................... 7 OR 9
    TAPE SPEED ....................... 10 TO 45 IPS
    TAPE ............................. 0.5 INCH, 1.5 MILS, IBM/ANSI
                                       COMPATIBLE

BORG WARNER               #PERT                              121
    TRACKS ........................... 30
    TAPE SPEED ....................... UP TO 1000 IPS
    TAPE WIDTH ....................... 1/2 INCH
    TAPE LENGTH ...................... 2400 FEET
    PACKING DENSITY .................. 15 KB/I/T
    SIGNAL/NOISE ..................... 24 DB
    DATA CAPACITY .................... 1.3E+9
    BANDWIDTH ........................ 6-15 MB/SEC/T

LEACH                     #MTR 7000                          311
    TRACKS ........................... 12
    TAPE SPEED ....................... 120 IPS
    TAPE WIDTH ....................... 1 INCH
    TAPE LENGTH....................... 9200 FEET
    PACKING DENSITY................... 16.7 KB/I/T
    SIGNAL/NOISE ..................... 22 DB
    DATA CAPACITY .................... 2.2E+10
    BANDWIDTH ........................ 2 MB/SEC/T

HEWLETT PACKARD           #3955D               $10200        111
    BANDWIDTH ........................ 300 KHZ
    CHANNELS ......................... 7
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD           #3955C               $14700        111
    BANDWIDTH ........................ 300 KHZ
    CHANNELS ......................... 14
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD           #3950A-011           $23800        111
    BANDWIDTH ........................ 500 HZ TO 2 MHZ
    CHANNELS ......................... 14
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD           #3960A/13065A/13063A $4796         111
    CONFIGURATION .................... RACK MOUNTED
    TAPE SPEED ....................... 15, 3 AND 3/4, 15/16 IPS
    CHANNELS ......................... 4
    RECORDING FORMAT ................. FM
    PASSBAND ......................... 5 KHZ
    S/N RATIO......................... 48 DB
    TRACKS ........................... 30

HONEYWELL                 #5600                $8730
    PORTABLE TAPE RECORDER
    CHANNELS.......................... 7
    SELECTABLE TAPE SPEED RANGE....... 15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)......... 300KHZ
    PACKING DENSITY................... UP TO 600PBI
    WEIGHT............................ 70LBS (32KG)
    INPUT VOLTAGE                      28VDC

HONEYWELL                 #96                  $17420
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            CHANNELS......................... 7
            SELECTABLE TAPE SPEED RANGE..... 15/16 TO 240IPS
            REEL SIZE........................ 16IN
            MAXIMUM BANDWIDTH(DIRECT)........ 2M HZ
            TAPE WIDTH....................... 1/2 IN

        AMPEX CORP                 #AR 700               $29,180        511
            TRACKS ......................... 14
            TAPE SPEED ..................... 60 IPS
            TAPE WIDTH ..................... 1 INCH
            RECORD MODE..................... DIRECT
            PACKING DENSITY ................ 20 KB/I/T
            SIGNAL/NOISE ................... 20 DB
            DATA CAPACITY .................. 8E+10 BITS
            BANDWIDTH ...................... 1 MB/SEC/T

219700 DATA BUFFER                                          ST010   21111
219700
219700 CAPABILITY TO ACCEPT VERY HIGH DATA RATES, PROVIDE SHORT DURATION
219700 STORAGE AND LOWER RATE DUMP CAPABILITY. USED IN ST015.
219700
219700     WORD LENGTH .................. 8 TO 32 BITS
219700     OUTPUT RATE .................. VARIABLE AT 0 TO 5 VDC
219700     STORAGE DURATION ............. INFINITE
219700
        RESEARCH INC               #812-3                $3500          111
            OUTPUT VOLTAGE ................. 5 V FS
            OUTPUT CURRENT ................. 1-5, 4-20, 10-50 MAMP
            OUTPUT IMPEDANCE ............... 1.2 K OHM ON 5 V SCALE
            CONVERSION RESOLUTION .......... 10 BITS
            PERCENT OUTPUT/UPDATE .......... 99.7
            DROOP RATE ..................... 0.1 %/MS
            SETTLING TIME .................. 50 MICROSEC
            UPDATE TIME .................... 2.2 MSEC
            MAX SIG AND HOLD CHANNELS ...... 32
            SIG AND HOLD CHANS PER CARD .... 4
101600 DIGITAL PHASE METER                                  ST011   41111
101600
101600 METER TO DISPLAY PHASE OF SIGNAL RECEIVED BY MICROWAVE
101600 INTERFEROMETER
101600
603002 BOOM CONTROLS                                        ST012   11114
603002
603002 CONTROLS FOR MICROWAVE INTERFEROMETER BOOMS
603002
425900 RECORDER - STRIP CHART                               ST015   11111
425900
425900 RECORD ANALOG MICROWAVE RADIOMETER DATA MONITORING SEA SURFACE
425900 TEMPERATURE AND ROUGHNESS.
425900
425900     FREQUENCY RESPONSE ................. 150.0 HZ
425900     SENSITIVITY .................. 10 MV/DIVISION
425900     CHANNELS ..................... 2
425900     INPUTS ....................... 2
425900
        BECKMAN INSTRUMENTS        #RP                   $3820          111
            FREQUENCY ...................... DC TO 130 HZ
            CHANNELS ....................... EVENT,TIME,2-DATA
            WRITING METHOD ................. THERMAL
            SENSITIVITY .................... 1MUV/MM TO 5V/MM
            RESPONSE TIME .................. 5MSEC FOR 10-90% OF 50MM PEN TR
            CHART SPEED .................... 1 TO 250 MM/SEC
            IRIG OUTPUT .................... OPTIONAL

        HEWLETT PACKARD            #7100BR WITH OPTION  $2295          111
                                    019 AND 023.
                                    17500A PLUG-IN
            CHANNELS ....................... 2 CHANNELS PLUS EVENT MARKER ON
                                             BOTH SIDES
            WRITING METHOD ................. ELECTRIC
            ACCURACY ....................... +/- 0.2 % FS
            VOLTAGE SPAN ................... 5 MV TO 100 V

        HEWLETT PACKARD            #7702B/8801A          $2750          111
            FREQUENCY RESPONSE ............. DC TO 125 HZ
            WRITING METHOD ................. THERMAL
            SENSITIVITY .................... 5 MV/DIV
            CHANNELS ....................... 2 CHANNELS TIMER/MARKER
            VOLTAGE RANGE .................. 5 MV TO 5 V PER DIV
            ACCURACY ....................... +/- 1 %

        HONEYWELL                  #1508B                $3300          111
            DATA CHANNELS................... 24
            EVENT CHANNELS.................. 4
            FREQUENCY RESPONCE.............. DC TO 25KHZ
            PAPER   SPEED................... 0.1 TO 120 IPS
            MOUNT........................... RACK
            PAPER WIDTH..................... 8IN

        HEWLETT PACKARD            #7708B/8802A          $8975
            CONFIGURATION .................. RACK MOUNTED
            CHART SPEED .................... 0.25, 0.5, 1, 2.5, 5, 10, 25,
                                             50, 100 MM/SEC
            FREQUENCY RESPONSE ............. 150 HZ
            CHANNELS ....................... 8
            WRITING METHOD ................. THERMAL
            INPUT RANGES ................... 1, 2, 5, 10, 20, 50, 100, 200,
                                             500, 1000 MV/DIV
            ACCURACY ....................... +/- 1%
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HONEYWELL                          #1856              $
     RESOLUTION ........................ 200 ELEMENTS/INCH (1000/SWEEP)
     RECORDING RATE .................... 8E+06 BITS/SEC
     CRT ............................... FIBER OPTICS
     SPOT SIZE ......................... 0.005 INCH
     SWEEP SPEED ....................... 20,000 LINES/SEC

HONEYWELL                          #1858              $
     SIZE-RACK MOUNTED ................. 8.75H X 19.1W X 21D
     WEIGHT (W/O ACCESSORIES) .......... 65 LBS.
     ACCESSORIES ....................... 6 LBS.
     CHANNELS .......................... 18
     RECORDING STYLIS .................. INERTIALESS-NO MOVING ELEMENT
     RESPONSE .......................... DC TO 5000 HZ
     INPUT SENSITIVITY ................. 100 MICROVOLT - 300 VOLTS
     ACCURACY .......................... 0.1 %
     PAPER SPEED ....................... 0.1 TO 120 IPS
     POWER ............................. 120/240 V, 50-400 HZ

HONEYWELL                          #1912              $7700          111
     PAPER WIDTH........................ 12IN
     CHANNELS........................... 24
     FREQUENCY RESPONCE................. DC TO 25KHZ
     PAPER SPEED........................ 200IPS
     SPEED VARIATION.................... 15 FORWARD, 12 REVERSE SPEEDS
     MOUNT.............................. RACK

BECKMAN INSTRUMENTS                #R                 $10759         111
     BANDWIDTH.......................... DC TO 130HZ
                 ....................... 5000 HZ WITH PR-500TAPE REC
     CHANNELS .......................... 1 TO 8 UP TO 24 SPEC ORDER
     REC FORMAT ........................ THERMAL RECTILINEAR
     CHART SPEED ....................... 0.1 TO 25 CM/SEC OTHERS AVAIL
     EVENT MARKERS .....................  2 (OPTION)
     DIMENSIONS ........................  65.5X21.5X22.5 INCHES
     POWER .............................  120V 50/60 HZ 250W

181000 SIGNAL GENERATOR                                   ST016 0011111
181000
181000 ACCURATELY REPRODUCE IN PULSE FORM THE OUTPUT OF A MICROWAVE
181000 RADIOMETER MONITORING SEA SURFACE STATE AND TEMPERATURE.
181000
          REPETITION RATE................ CW
181000    OUTPUT VOLTAGE ....................... +/- 5 VDC
181000
     INTERSTATE ELECTRONICS CORP    #P25              $1095          111
     REPETITION RATE ................... 1 HZ TO 50 MHZ IN 4 RANGES
     POLARITY .......................... 1 POSITIVE AND 1 NEGATIVE CHAN
     WIDTH ............................. <10 NSEC TO 1 SEC
     DELAY ............................. <10 NSEC TO 1 SEC
     AMPLITUDE ......................... 10, 5, 1 V

WAVETEK                            #162               $945           111
     BANDWIDTH ......................... 0.00003 HZ TO 30 MHZ
     OUTPUT ............................ 80 DB ATTENUATION/10 DB STEPS
                                         10 V P-P INTO 50 OHMS
     DC OFFSET ......................... +/- 5 VOLTS INTO 50 OHMS
     STABILITY ......................... +/- 0.25% PER 24 HOURS

TEKTRONIX INC                      #FG 501            $325           111
     FREQUENCY RANGE ................... .001 HZ TO 1 MHZ
     AMPLITUDE OUTPUT .................. 7.5 V P-P INTO 50 OHMS
     WAVEFORMS ......................... SINE, PULSE, SQUARE, TRIANGLE,
                                         RAMP
179500 SPECTRUM ANALYZER                                  ST017   11111
179500
179500 SUPPORT SETUP, CHECKOUT AND SIGNAL OUTPUT ANALYSIS OF RF RADIO-
179500 METER UNIT AND.SWEEP RECEIVER (CRT DISPLAY OF SWEEP RECEIVER AMP-
179500 LITUDE VERSUS FREQUENCY).
179500
179500    BANDWIDTH .............................. 30 TO 10000 MHZ
179500    RESOLUTION ..................... 2 %
179500    SENSITIVITY .................... 10 MV/DIVISION
179500
     TEKTRONIC INC                 #R491              $4995          112
     FREQUENCY RANGE ................... 10 MHZ TO 40 GHZ
     DISPERSION, FREQ SPAN ............. 1 KHZ/DIV TO 10 MHZ/DIV
     RESOLUTION BANDWIDTH .............. 1 KHZ TO 100 KHZ
     INCIDENTAL FM ..................... <300 HZ AT FUNDAMENTAL

TEKTRONIX INC                      #1401A-4           $3725          111
     FREQUENCY RANGE ................... 1 TO 500 MHZ
     INTERMODULATION DISTORTION ........ < 60 DB FULL SCREEN

SPECTRA-PHYSICS                    #470               $2800          111
     FOR USE IN LASER ALIGNMENT
      SPECTRAL RANGE.................... 2 TO 8 GHZ
     INSTRUMENTAL BANDWIDTH............. 6.7 TO 27 MHZ

055050 CAMERA - STILL (VISIBLE)                           ST020   31111
055050
055050 STILL PHOTOGRAPHIC COVERAGE OF THE EARTH TARGET AREA IN THE
055050 VISIBLE REGION (REQUIRES SIMULTANEOUS PHOTOGRAPH IN THE INFRARED
055050
055050    VIEW ANGLE ........................... 14.5 DEGREES
055050    RESOLUTION ..................... 100 LINES/MM
055050    FILM FORMAT .................... 5 INCHES
055050    SHUTTER ........................ 8 TO 1/8000 SEC
055050
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GRAFLEX                        #XL                  $365          111
     CONFIGURATION ................... HAND HELD OR STAND MOUNTED
     FILM FORMAT ..................... 3.25 X 4.25 INCH
     LENS ............................ INTERCHANGEABLE

HASSELBLAD                     #500 EL              $1411         111
     TYPE ............................ SINGLE LENS REFLEX
     DRIVE ........................... ELECTRICAL OR MANUAL
     LENS ............................ 80 MM PLANAR F/2.8 ZEISS
                                       50 MM DISTACON F/4.0
     CLOSE-UP LENS ................... PROXAR 0.5 FOCUS RANGE
                                       17.25 TO 24.25 IN
                                       PROXAR 1.0 FOCUS RANGE
                                       22.25 TO 42.5 IN
     FILM SIZE ....................... 2.25 X 2.25 IN
     MAGAZINE ........................ CASSETTE AND PLATE

J A MAURER INC                 #500                 $8-9000       111
     FILM SIZE ....................... 5 IN MS 33523
     FORMAT .......................... 4.5 X 4.5 IN
     SHUTTER ......................... 1/8000 TO 1/200 SEC
     MODE ............................ PULSE OR AUTOCYCLE
     FRAME RATE ...................... UP TO 5 FR/SEC
     FOCAL LENGTH .................... 24 IN
     NO REQD (LENSES) ................ 2
     RESOLUTION ...................... 104 L/MM AWAR
     MAGAZINE ........................ 250 FT 5 IN FILM
     MIL-SPEC  /  AIRBORNE

104180 DISPLAY TERMINAL                                    ST020   21111
104180
104180 TERMINAL CONSISTING OF ALPHANUMERIC KEYBOARD AND CRT DISPLAY FOR
104180 MONITORING EXPERIMENT ACTIVITIES
104180
     RESEARCH INC              #3300                $1580
     FORMAT...........................24 LINESX72 OR 80 CHARACTERS
          ............................24 LINESX40 CHARACTERS
          ......... ................. 12 LINESX72 OR 80 CHARACTERS
     REFRESH RATE.....................60 HZ
     TRANSFER RATE....................110 TO 2400 BAUD
     CHARACTER FORM...................5X7 DOT MATRIX
     DIMENSIONS.......................15-1/2WX13-1/2HX23-1/2D INCH
     WEIGHT...........................39LB (17.7KG)

RESEARCH INC                   #DPS-812             $21,700       111
     COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
     DEC-PDP8-F MINI-COMPUTER, #3301 OPERATORS CONTROL CONSOLE,
     PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
     CHANNELS ...................... 32
     MEMORY SIZE ................... 8K WORDS
RESEARCH INC                   #812-3301            $1555         111
     SCREEN FORMAT ................... 12 LINES X 72 OR 80 CHARACTERS,
                                       24 LINES X 40 CHARACTERS
     CHARACTER FORMAT ................ 5 X 7 DOT MATRIX
     TRANSFER RATE ................... 110 TO 2400 BAUD, 10 OR 11 BIT
                                       CHARACTERS
     MODES ........................... HALF OR FULL DUPLEX-SWITCHABLE
                                       LOCAL OR REMOTE

HEWLETT PACKARD                #2600A               $3580         111

TEKTRONIC                      #4002A/021-00XX-00   $9550         111
     DISPLAY MEDIUM .................. 11 INCH DIRECT-VIEW, BISTABLE
                                       STORAGE CRT WITH REFRESHED
                                       SCRATCH PAD AREA
     DISPLAY AREA .................... 8.3 INCHES HORIZONTAL X 6.1
                                       INCHES VERTICAL
     ALPHANUMERIC MODE
          FORMAT ..................... 39 LINES OF 85 NORMAL OR ITALIC
                                       CHARACTERS IN MAIN AREA, ONE
                                       LINE OF 84 CHARACTERS IN
                                       SCRATCH PAD AREA
          CHARACTER SET .............. 96 UPPER AND LOWER CASE PRINT-
                                       ING CHARACTERS (ASCII CODE)
          CHARACTER SIZE ............. 70X90 MILS (CAN BE DOUBLE SIZE)
          CHARACTER GENERATION ....... 7X9 DOT MATRIX
          CURSOR ..................... PULSATING 7X9 MATRIX
     GRAPHIC MODES ................... LINEAR INTERPOLATE, INCREMENTAL
                                       PLOT, POINT PLOT, 1024X1024
                                       ADDRESSABLE POINTS, 1024X761
                                       VIEWABLE POINTS
     GRAPHIC INPUT MODE .............. 1024 (X), 761 (Y) POINTS, JOY-
                                       STICK CONTROLLED, CROSS-HAIR
                                       CURSOR

102700 COMPUTER                                            ST024   21111
102700
102700 COMPUTER CAPABILITY TO PROVIDE BASIC POINTING AND TRACKING INFOR-
102700 MATION RELATIVE TO ATL STABILITY AND FLIGHT PATH REQUIREMENTS.
102700
     DATA GENERAL CORP         #NOVA 800                          111
     WORD LENGTH ..................... 16 BIT
     CYCLE TIME ...................... 800 NANOSEC.
     CORE MEMORY ..................... 32K MAX

DATA GENERAL CORP              #SUPERNOVA SC                      111
     WORD LENGTH ..................... 16 BIT

DATA GENERAL CORP              #NOVA 1200                         111
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     WORD LENGTH ...................... 16 BIT
     CYCLE TIME ....................... 1200 NANOSEC.
     CORE MEMORY ...................... 32K MAX.

VARIAN DATA MACHINES          #520/I                                111
     MEMORY CYCLE TIME ................ 1.5MICROSEC.
     MEMORY ........................... EXPANDABLE,4096BYTES(8BITS)TO
                                        32,768BYTES
     REGISTERS ........................ 12
     OPERAND PRECISION ................ UP TO 32 BITS

VARIAN DATA MACHINES          #R-620/I                              111
     BASIC COMMANDS ................... OVER 100
     ADDRESSING MODES ................. 6
     MAX.WORDS ........................ 32,768
     WORD LENGTH ...................... 16 OR 18 BIT
     REGISTERS ........................ 6
     NOTE:                              HAS FULL RANGE INTERFACE
                                        HARDWARE

CLARY DATACOMP SYSTEMS INC    #404                                  111
     SIMULTANEOUS TERMINALS ........... 16
     INPUT ............................ TELETYPEWRITER KEYBOARD
     ACCUMULATOR ...................... 64 BIT
     REGISTERS ........................ 16 BIT INDEX (2 EACH)
     WORD LENGTH ...................... 16, 32, 48, 64 BITS
     MEMORY CAPACITY .................. 1024 16 BIT WORDS, 4095 16 BIT
                                        WORDS,OR ADDITIONAL 4096 16 BIT
                                        WORDS. TOTAL 65536 WORDS

GENERAL AUTOMATION INC.       #18-30                                111
     FUNCTION ......................... SUPERVISE SMALLER COMPUTERS
     MEMORY............................ 8K CORE
     CYCLE TIME ....................... 1.2 MICROSEC.

GENERAL AUTOMATION INC.       #SPC-16                               111
     MEMORY ........................... 16K
     WORD LENGTH ...................... 16 BITS
     READ/WRITE CYCLE MEMORY TIME ..... 900 TO 1440 NANOSEC.
     READ ONLY MEMORY ................. 400 TO 720 NANOSEC.
     INPUT/OUTPUT TIME ................ 1.6 TO 2.8 MICROSEC.
     DMA TRANSFER RATE ................ 0.694E+06 TO 2.5E+06

GENERAL AUTOMATION INC.       #SPC-12                               111
     MEMORY ........................... 4K TO 16K
     WORD LENGTH ...................... 8 BITS
     CYCLE TIME ....................... 2.16 MICROSEC
     STORED PROGRAM EXECUTION RATE .... 0.23E+06/SEC
     I/O TRANSFER RATE ................ 0.46E+06/SEC
     REGISTERS ........................ 6 12 BIT REGISTERS
     ACCUMULATORS ..................... 4 12 BIT

DIGITAL EQUIPMENT CORP        #PDP-8/E               $22000         111
     MEMORY ........................... 4096(CORE)EXPANDABLE TO
                                        32,768 WORDS
     WORD ............................. 12 BIT
     CYCLE TIME ....................... 1.5 MICROSEC.
     ADDRESS REFERENCE ................ 8,16,24,OR 32 BIT LEVEL
     NOTE:                              HAS FULL RANGE INTERFACE
                                        HARDWARE

484000 MONITOR - TV                                        ST026   31111
484000
484000 DISPLAY HIGH RESOLUTION TELEVISION PICTURES IN REAL-TIME OR FROM
484000 VIDEO TAPE.  USED ON ST015, ST025, ST035, ST045 AND ST055.
484000
484000    RESOLUTION ...................... 625 LINES
484000    FRAME RATE ...................... 30 FPS
484000    SCREEN SIZE ..................... 10 IN (25.4 CM)
484000
    COHU ELECTRONICS INC.         #COF                   $775           111
     BANDWIDTH ........................ 30 MHZ
     HORIZONTAL LINES ................. 1225
     FIELDS ........................... 60/SEC.

    CONRAC CORPORATION            #RQA 14/P              $1620          111
     VIDEO AMPLIFIER
         COMPOSITE .................... 0.3 - 3.0 V P-P
         NONCOMPOSITE ................. 0.3 V P-P FOR 100 PCT CONTRAST
                                        3.0 V P-P MAXIMUM AT CRE PREAMP
                                        OVERLOAD
     VIDEO INPUT IMPEDANCE ............ 50 K OHM MIN SHUNTED BY MAX 10
                                        PFD SIGNAL OF 20 V P-P; HUM
                                        SUPPRESSION 40 DB 60-1000 HZ
     VIDEO FREQUENCY RESPONSE
         AT 50 PCT OF MODULATION ...... FLAT +/- 1 DB  TO 30 MHZ, -6 DB
                                        AT 40 MHZ
         AT 30 PCT OF DEPTH MOD ....... FLAT +/- 1 DB  TO 30 MHZ, -2 DB
                                        AT 40 MHZ
     PULSE RESPONSE ................... LESS THAN 15 NS RISE/FALL TIME
                                        AT 50 PCT DEPTH OF MODULATION
     EXTERNAL SYNC .................... COMPOSITE OR SEPARATE H/V SYNC:
                                        0.5 V TO 10 V P-P, GREATER THAN
                                        5K OHM INPUT IMPEDANCE
     LINEARITY ........................ +/- 1 PCT PICTURE HEIGTH
     RETRACE TIME
         HORIZONTAL ................... 5 MICROSEC MAX
         VERTICAL ..................... 400 MICROSEC MAX
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      SCANNING FREQUENCY
          HORIZONTAL .................. 15 - 40 KHZ
          VERTICAL .................... 15 - 60 FIELDS/SECOND

    COHU INC. ELECTRONICS DIV     #960C                  $5260
        PICTURE SIZE .................. 7-3/16W X 5-3/8H INCHES
        HORIZONTAL SCAN ............... 945 LINES, 50 OR 60 FIELDS/SEC
                        ............... 873 LINES, 60 FIELDS/SEC
        VIDEO BANDWIDTH ............... 20 MHZ +/- 2 DB
        POWER ......................... 25-28.5 VDC, 150 WATTS

103520 DATA PROCESSING EQUIPMENT                             ST035   11111
103520
103520 HIGH SPEED DIGITAL DATA CONVERSION TO ANALOG FORM COMPATIBLE FOR
103520 REAL TIME DISPLAY.  USED ON ST015, ST025 AND ST035.
103520
103520    CHANNELS ..................... 32
103520    DIGITAL-DATA ......................... 10E+06 BPS
103520
    TENNELEC                      #TC500                 $6000         111
        CONVERSION TIME................ 3MICRO SEC
        CAPACITY....................... 2048 CHANNELS
        CONFIGURATION.................. COMPATIBLE WITH NIM
    TENNELEC                      #TC 520                $750          111
        CHANNELS....................... 8
        CHANNEL DWELL TIME............. 300NSEC
        CONFIGURATION.................. NIM COMPATIBLE

410000 STORAGE - GAS SOURCE                                  ST045   81111
410000
410000 GAS SOURCE STORAGE BOTTLES CAPABLE OF STORING VARIOUS GASES AT
410000 HIGH PRESSURES. SIMILAR TO STANDARD K-BOTTLES.  USED IN ST015,
410000 ST025 AND ST035.
410000
410000    VOLUME - PHYSICAL ............ 5 CU FT EA (0.15 CU M)
410000    PRESSURE MAXIMUM ............. 1000 PSI
410000
003400 GENERATOR - AEROSOL                                   ST046   11135
003400
003400 CAPABILITY TO PRODUCE FINE LIQUID PARTICLES REQUIRED FOR VARIOUS
003400 EXPERIMENTS.  USED IN ST015, ST025 AND ST035.
003400
314000 GENERATOR - ION                                       ST047   11113
314000
314000 IONIZE AEROSOL PARTICLES SO AS TO OBSERVE ZERO GRAVITY MOTION.
314000
    METRONICS ASSOCIATES          #BULLETIN 24-70                      111

211000 VAPORIZER - WATER                                     ST048   21135
211000
211000 CAPABILITY TO PROVIDE COOL WATER VAPOR TO EXPERIMENT CONTAINER.
211000
229600 LIGHT SOURCE                                          ST049   21111
229600
229600 PORTABLE LIGHT SOURCE USED  FOR PHOTOGRAPHING EXPERIMENT OPERA
229600 TIONS AND RESULTS.  USED IN ST015, ST025 AND ST035.
229600
229600    ILLUMINATION ................. 100 TO 1000 LUMENS
229600    DISTANCE ..................... UP TO 30 FEET
229600
297500 ENVIRONMENT CHAMBER                                   ST050   11135
297500
297500 PROVIDE SPECIAL CHAMBER TO MONITOR OPTICAL PROPERTIES OF AEROSOLS
297500 WITH CAPABILITY TO PERTURBATE THE ENVIRONMENT WITH IONS AND
297500 OBSERVING THE AEROSOLS THROUGH A MICROSCOPE AND PHOTOGRAPHING THE
297500 SCENE. USED IN ST015, ST025 AND ST035.
297500
269000 MICROSCOPE                                            ST051   21111
269000
269000 MICROSCOPIC EXAMINATION OF AEROSOL PARTICLES IN THE VISUAL RANGE.
269000 ALSO COMPATIBLE WITH BIOLOGICAL AND METALURGICAL EXPERIMENTS.
269000
269000    MAGNIFICATION RANGE .................. 50 TO 1000 X
269000    PHOTOGRAPHIC CAPABILITY .............. YES
269000
269000 USED ON ST01, ST025 AND ST035.

    BAUSCH AND LOMB INC           #B57-636               $876          111
        OBJECTIVES .................... 4 FLAT FIELD
        TYPE OBJECTIVE ................ 5X, 0.8 NA; 10X, 0.25 NA; 40X,
                                        0.65 NA; 100X, 1.25 NA
        ILLUMINATOR ................... 5 STEP, LOW VOLTAGE TRANSFORMER
        EYEPIECES ..................... PAIRED 10X

    CARL ZEISS CO                 #ULTRAPHOT II          $8000         111
        CONFIGURATION ................. LOOSE EQUIP
        MAGNIFICATION ................. 2.5X TO 2500X
        CAMERA ATTACHMENT ............. POLAROID, 4X5 FILM, 35 MM ROLL

095055 CAMERA - CINE                                         ST054   61111
095055
095055 PHOTOGRAPHIC RECORD OF THE ACTIVITY OF AEROSOL PARTICLES IN
095055 NORMAL, SLOW MOTION AND TIME-LAPSE SEQUENCES
095055 USED IN ST015, ST015, ST035, ST045, ST055 AND ST065.
095055
095055    VIEW ANGLE ................... 40 DEGREES
095055    RESOLUTION ................... 200 LINES/MM
095055    SHUTTER ...................... 1/50 TO 1/500 SEC
095055    FILM FORMAT .................. 16 MM
095055    CAMERA SPEED ................. 1, 8, 16, 64 FPS
095055
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CINEMA BEAULIEU CORP             #R-16B               $3000        112
     CONFIGURATION .................... BENCH/LOOSE EQUIP
     OPERATION MODE ................... VARIABLE FRAME RATE OR SINGLE
                                        FRAME PULSE OPERATION UNDER
                                        REMOTE CONTROL
     SPEED ............................ 2 TO 64 FRAMES/SEC (VARIABLE)
     FILM SIZE ........................ 16 MM
     LENS ............................. C MOUNT LENS SYSTEM
     FILM CAPACITY .................... VARIOUS FILM MAGAZINES

 J A MAURER INC                  #317-E1              $4500        311
     MODES ............................ 8, 16, 32, 64 FPS ELECT CONT
     SHUTTER .......................... ROTARY
     SHUTTER SPEED .................... 1/62.5 TO 1/500 SEC
     FILM ............................. 16 MM MAGAZINE
     FILM CAPACITY .................... 150 FT THIN BASE
     LENS ............................. 25 MM, F/1.4
     RESOLUTION ....................... 236 L/MM ON AXIS, 150 L/MM AWAR

424000 TAPE RECORDERS (HIGH-SPEED MULTICHANNEL)             ST056   11111
424000
424000 MULTIPLE CHANNEL HIGH SPEED ELECTRONIC DATA RECORDING SYSTEM.
424000 USED ON ST015, ST025 AND ST035.
424000
424000    BANDWITH ....................... 1 KHZ TO 2.0 MHZ
424000    CHANNELS ....................... 14
424000    SIGNAL TYPE .................... ANALOG
424000
 AMPEX CORPORATION               #AR-200                           121
     BANDWIDTH ........................ 100 HZ TO 3125 HZ THROUGH
                                        300 HZ TO 250 KHZ
     TAPE WIDTH ....................... 0.5 INCH
     TAPE SPEED ....................... 1.875 TO 60 IPS
     RECORDING TIME ................... 8 MINUTES TO 4 HRS AND 16 MINS
     FORMAT ........................... DIGITAL
     TRACKS ........................... 8 DIGITAL, 7 ANALOG

 SANGAMO ELECTRIC                #SABER III           $26,500      111
     TRACKS ........................... 14
     TAPE WIDTH ....................... 1 INCH
     TAPE SPEEDS....................... 8 SELECTABLE SPEEDS FROM 15/16
                                        TO 120 IPS
     FREQUENCY RESPONSE ............... 400 HZ TO 2.0 MHZ
     RECORDING RATE ................... 600 KBPS AT 120 IPS SERIAL MODE
     WEIGHT ........................... 100 POUNDS

 DIGI-DATA CORPORATION           #1600                $2650        111
     TAPE SPEED ....................... 25, 18.75, 12.5 IPS
     TRACKS ........................... 7 OR 9 TRACK
     DATA DENSITY ..................... 1600 CPI PHASE ENCODED
                                        200, 556, 800 CPI NRZI
     TAPE ............................. 0.5 INCH, 1.5 MIL, 1200 FEET

 DIGI-DATA CORPORATION           #1700/PDP-11/7-9     $5250        111
                                   TRACK NRZI
     TAPE SPEED ....................... 45, 37.5, 25, 18.75, 12.5 IPS
     TAPE ............................. 0.5 INCH, 1.5 MIL, IBM/ANSI
                                        COMPATIBLE, 10.5 INCH REEL
     TRACKS ........................... 7 OR 9
     DATA DENSITY ..................... PHASE ENCODED
                                        COMPATIBLE

 HEWLETT PACKARD                 #7570B/C             $ 4600       111
     TAPE FORMAT ...................... 800, 556, OR 200 CPI NRZI AND
                                        1600 CPI PHASE-ENCODED
     CHANNELS ......................... 7 OR 9
     TAPE SPEED ....................... 10 TO 45 IPS
     TAPE ............................. 0.5 INCH, 1.5 MILS, IBM/ANSI
                                        COMPATIBLE

 BORG WARNER                     #PERT                             121
     TRACKS ........................... 30
     TAPE SPEED ....................... UP TO 1000 IPS
     TAPE WIDTH ....................... 1/2 INCH
     TAPE LENGTH ...................... 2400 FEET
     PACKING DENSITY .................. 15 KB/I/T
     SIGNAL/NOISE ..................... 24 DB
     DATA CAPACITY .................... 1.3E+9
     BANDWIDTH ........................ 6-15 MB/SEC/T

 LEACH                           #MTR 7000                         311
     TRACKS ........................... 12
     TAPE SPEED ....................... 120 IPS
     TAPE WIDTH ....................... 1 INCH
     TAPE LENGTH....................... 9200 FEET
     PACKING DENSITY................... 16.7 KB/I/T
     SIGNAL/NOISE ..................... 22 DB
     DATA CAPACITY .................... 2.2E+10
     BANDWIDTH ........................ 2 MB/SEC/T

 HEWLETT PACKARD                 #3955D               $10200       111
     BANDWIDTH ........................ 300 KHZ
     CHANNELS ......................... 7
     RECORDING FORMAT ................. DIRECT OR FM
 HEWLETT PACKARD                 #3955C               $14700       111
     BANDWIDTH ........................ 300 KHZ
     CHANNELS ......................... 14
     RECORDING FORMAT ................. DIRECT OR FM

 HEWLETT PACKARD                 #3950A-011           $23800       111
     BANDWIDTH ........................ 500 HZ TO 2 MHZ
     CHANNELS ......................... 14
     RECORDING FORMAT ................. DIRECT OR FM
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HEWLETT PACKARD               #3560A/13065A/13063A $4796          111
     CONFIGURATION ..................... RACK MOUNTED
     TAPE SPEED ........................ 15, 3 AND 3/4, 15/16 IPS
     CHANNELS .......................... 4
     RECORDING FORMAT .................. FM
     PASSBAND .......................... 5 KHZ
     S/N RATIO.......................... 40 DB
     TRACKS ............................ 30

HONEYWELL                     #5600               $9730
     PORTABLE TAPE RECORDER
     CHANNELS........................... 7
     SELECTABLE TAPE SPEED RANGE........ 15/16 TO 60IPS
     MAXIMUM BANDWIDTH(DIRECT).......... 300KHZ
     PACKING DENSITY.................... UP TO 600PBI
     WEIGHT............................. 70LBS (32KG)

HONEYWELL                     #96                 $17420
     CHANNELS........................... 7
     SELECTABLE TAPE SPEED RANGE........ 15/16 TO 240IPS
     REEL SIZE.......................... 16IN
     MAXIMUM BANDWIDTH(DIRECT).......... 2M HZ
     TAPE WIDTH......................... 1/2 IN

APPEX CORP                    #AR 700             $29,180         511
     TRACKS ............................ 14
     TAPE SPEED ........................ 60 IPS
     TAPE WIDTH ........................ 1 INCH
     RECORD MODE........................ DIRECT
     PACKING DENSITY ................... 20 KB/I/T
     SIGNAL/NOISE ...................... 20 DB
     DATA CAPACITY ..................... 8E+10 BITS
     BANDWIDTH ......................... 1 MB/SEC/T

APPEX CORP                    #AR 1700            $28,000         112
     TRACKS ............................ 14
     TAPE SPEED ........................ 120 IPS
     TAPE WIDTH ........................ 1 INCH
     RECORDING MODE..................... DIRECT
     PACKING DENSITY ................... 20 KB/I/T
     SIGNAL/NOISE ...................... 20 DB
     DATA CAPACITY ..................... 6.2E+10
     BANDWIDTH ......................... 2 MB/SEC/T

459608 SPECTROMETER - GAMMA RAY                              ST063   11111
459608
459608 MEASURE SPACECRAFT GAMMA RADIATION BY CRYOGENICALLY COOLED LITH-
459608 IUM DRIFTED GERMANIUM DETECTOR WITH ANTI-COINCIDENCE SHIELD. USED
459608 IN ST01S AND ST03S.
459608
459608    ELECTROMAGNETIC ENERGY.......  100 KEV TO 6 MEV
459608
459608 SPECTROMETER - CHARGED PARTICLE                       ST064   11111
459608
459608 THIRTY MULTI-WIRE PROPORTIONAL COUNTER WITH INTERVENING LAYERS OF
459608 TISSUE EQUIVALENT PLASTIC.  USED IN ST01S AND ST03S
459608
459608    PROTON ENERGY RANGE ........... 5 TO 230 MEV
459608    DEUTERIUM ENERGY RANGE......... 10 TO 300 MEV
459608    TRITIUM ENERGY RANGE........... 15 TO 230 MEV
459608    HELIUM-3 NUCLEI ENERGY RANGE . 20 TO 400 MEV
459608    ALPHA PARTICE ENERGY RANGE ... 25 TO 450 MVE
459608
459618 SPECTROMETER - NEUTRON                                ST065   11111
459618
459618 LIQUID SCINTILLATOR WITH ANTI-COINCIDENCE SHIELD PULSE SHAPE
459618 DISCRIMINATOR.  USED ON ST01S AND ST03S.
459618
459618    NEUTRON ENERGY RANGE ....      0.5 TO 15 MEV
459618
103500 DATA CONVERTER - ANALOG TO DIGITAL                    ST067   21111
103500
103500 CONVERT ANALOG SIGNAL DATA TO DIGITAL DATE FOR RECORDING AND
103500 LATER DUMPING TO GROUND STATIONS.  USED ON ST01S AND ST03S.
103500
308500 FILM BADGE                                            ST070  121111
308500
308500 MONITOR ASTRONAUT PERSONAL RADIATION DOSE, DOSE RATE AND DOSE
308500 HISTORY, USED IN ST01S, ST02S AND ST03S.
308500
308500    DOSE RATE ..................... 0 - 0.1 MR/HR
308500                                    0 - 1000 R/HR
308500
308500 DOSIMETER - THERMOLUMINESCENT                         ST071   41111
308500
308500 PASSIVE DOSIMETER USING THERMOLUMINESCENCE TO MONITOR RADIATION.
308500 USED IN ST01S AND ST02S.
308500
308500    ENERGY RANGE DOSE ............. 1 TO 10E+05 RADS
308500
048700 REFRIGERATOR                                          ST080   11111
048700
048700 PROVIDE A COLD STORAGE AREA TO HOUSE SPECIMEN.  USED IN ST01S,
048700 ST02S AND ST03S.
048700
048700    TEMPERATURE ................... 3 C (270 K)
048700    SIZE APPROXIMATELY ............ 3 X 2 X 1 FT (76.2X50.7X25.4CM)
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048700
   DILLCN-LILLY                      #512-C              $875         112
        CAPACITY........................ 12.3 CU FT
        TEMPERATURE ....................  3.7 C
        SHIFLDED AREA ..................        NONE
        CRAWERS ........................ 12
        COMPRESSOR...................... 0.25 HP
        POWER .......................... 115  V 60 HZ
        WEIGHT ......................... 420  LBS
        CIMENSIONS ..................... 36X56.5X28.5 INCHES

   JORDAN                            #FT-1-BR            $1177        112
        TEMPERATURF .................... 2.22-6.11C IN 1.11C INCR.
        CAPACITY ....................... 22.4 CU FT
        COMPRESSOR ..................... 0.25 HP
        SHIELDEC AREA .................. NONE
        DRAIN .......................... NONE REQUIRED
        POWER .......................... 115V 60 HZ 6A
        DIMENSIONS...................... 78X28.5X31.625 INCHES

   BIRKEN MANUFACTURING CO           #STM-KL(DC-AC)      $335         112
        CAPACITY ....................... 8 FT**3
        VOLTAGE ........................ 115 VAC, 12, 24, 32 VDC

   FRIGID CAB                        #14                 $725         112
        CAPACITY........................ 14 CU FT
        TEMPERATURE..................... -6.7 TO +15 C
        SHIFLDED AREA .................. NONE
        EXPLOSICN-PROOF................. YES
        SPEARATE FREEZING COMP. ........ YES
        COMPRESSOR ..................... 0.25HP
        POWER .......................... 115V 60 HZ 3.5A
        DIMENSIONS(MAIN CHMBR).......... 26.5X20X36.5 INCHES

217500 CCLONY GROWTH ENVIRONMENTAL CHAMBER                   STC 1   11112
217500
217500 HOUSING FOR COLONIES OF BACTERIA WHICH CAN BE OBSERVED DURING
217500 EXPERIMENT.  USED IN ST01S, ST02S AND ST03S.
217500
217500    SIZE APPROXIMATELY ........... 5 X 5 X 7 IN (13 X 13 X 18 CM)
217500
438500 MICROBIOLOGICAL SAMPLE STORAGE                        ST082   21112
438500
438500 STORAGE RACK FOR SPACE-TYPE PLASTIC BAG, SWABS AND CAPSULES TO
438500 DESTROY BACTERIA IN CASE OF BREAKAGE.  USED IN ST01S, ST02S AND
438500 ST03S.
438500
438500    SIZE APPROXIMATELY ........... 16X13X6 IN (40X33X15 CM)
438500
217500 INCUBATOR                                             ST083   11111
217500
217500 CONTAINER USED TO PROVIDE VARIABLE TEMPERATURE ENVIRONMENTS FOR
217500 BIOSCIENCE SPECIMEN. USED IN ST01S, ST02S AND ST03S.
217500
217500    SIZE APPROXIMATELY ................. 2X1.5X0.5 FT (66X51X15 CM)
217500    TEMPERATURE ........................ TO 100 F (40 C)
217500
   SARGENT WELCH SCIENTIFIC CO.  #S-43306-B              $925         111
        RANGE .......................... 35 TO 70C
        MAX. TEMP ...................... 90C

042000 CCULTER PRINTER-COUNTER                               ST084   11111
042000
042000 PROVIDE AUTOMATIC BLOOD ANALYSIS (HEMOGLOBIN, HEMATOCRIT, RED
042000 BLOOD CELL COUNT, WHITE BLOOD CELL COUNT, MEAN CELL VOLUME, MEAN
042000 CELL HEMOGLOBIN AND IT'S CONCENTRATION).  USED IN ST01S, ST02S
042000 AND ST03S.
042000
   CCULTER ELECTRONICS               #FN                 $5000
        PARTICLE SIZE ....................0.003 TO 24 MICRONS
        COUNTING RATE ....................0.040 ML/SEC
        DIMENSIONS........................49CM H X 35 CM W X 44 CM D
        WEIGHT ...........................54LB (24.5KG)

   COULTER ELECTRONICS INC        #S                     $50000
        PARAMETERS ..................... HEMOGLOBIN, HEMATOCRIT, RED
                                         BLOOD CELL COUNT, WHITE BLOOD
                                         MEAN CELL HEMOGLOBIN, AND MEAN
                                         CELL COUNT, MEAN CELL VOLUME,
                                         CELL HEMOGLOBIN CONCENTRATION
        TYPE ........................... AUTOMATIC

   COULTER ELECTRONICS INC        #2B1-6                 $10000       112
        PARAMETERS ..................... HEMOGLOBIN, HEMATOCRIT, RED
                                         BLOOD CELL COUNT, WHITE BLOOD
                                         CELL COUNT, MEAN CELL VOLUME,
                                         MEAN CELL HEMOGLOBIN, AND MEAN
                                         CELL HEMOGLOBIN CONCENTRATION
        TYPE ........................... MANUAL

459620 SPECTROMETER - VOLUMETRIC                             ST085   11111
459620
459620 PROVIDE A PHOTOGRAPHIC MEANS TO MEASURE INDEPENDENT VOLUME OF
459620 CELLS AND CELL SHAPES. USED IN ST01S, ST02S AND ST03S.
459620
149300 ELECTROPHORESIS APPARATUS                             ST088   11111
149300
149300 MEASURE ELECTROPHORESIS MOBILITY, SURFACE-ZETA POTENTIAL, AND
149300 SURFACE CHARGE DENSITY OF CELL LINES OVER THEIR LIFE CYCLE.  USED
149300 IN ST01S AND ST02S.
149300
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    BAUSCH - LOMB INC              #SPECTROPHOR I                    111
        MIGRATION VOLTAGE ............... 0-500V
        MIGRATION CURRENT ............... 0-300MA
        UV LIGHT SOURCE ................. DEUTERIUM
        VISIBLE LIGHT SOURCE ............ QUARTZ IODINE
        MONOCHROMATOR RANGE ............. 200-650 MILLIMICRONS
        NO. SAMPLES ..................... 16
        MIGRATION TIME .................. 20MINUTES APPROX.
        BUFFER GEL THICKNESS ............ 1.7MM
        GEL COMPOSITION ................. AGAROSE

067000 CENTRIFUGE                                          ST090   11111
067000
067000 PROVIDE VARIABLE GRAVITY ENVIRONMENTS TO BIOSCIENCE SPECIMEN
067000 GENERALLY LIMITED TO TEST-TUBE SIZE CONTAINERS.  USED IN ST01S,
067000 ST02S AND ST03S.
067000
067000    GRAVITY LEVEL INDUCED ........ UP TO 10 G REQUIRED
067000
    CLAY-ADAMS, INC                #1CC4                $324
        SPEED RANGE......................800 TO 3040 RPM
        SAMPLES..........................12 (MAX), 15 ML EACH
        DIMENSIONS.......................15X12X26 INCHES
        CONFIGURATION....................BENCH MOUNT

    INTERNATIONAL EQUIPMENT CO     #2C211/2C215/20216    $85         112
        CONFIGURATION ................... BENCH/LOOSE EQUIP
        APPLICATION ..................... MICRO OR SEMI-MICRO ANALYSIS
        SPINNING SPEED .................. 1780 RPM
        SPIN STABILIZATION TIME.......... 10 SEC
        ACCOMODATIONS ................... 0.5, 1, 2, 3, 5 ML TUBES

    ADAMS                          #DYNAC               $267
        SPINNING RATE.................... 700 TO 2500RPM
        APPLIED GRAVITY.................. 55 TO 1000 RCF
        SAMPLE CAPACITY.................. 24

    MSE                            #GT-4                $410
        SPINNING SPEED................... 4000RPM
        APPLIED GRAVITATION.............. 2900RCF
        SAMPLE CAPACITY.................. 4

    BAUSCH AND LOMB INC            #SYSTEM CENTRIFUGE
        CAPACITY ................. 100 SAMPLES
        TIME TO SPIN DOWN ........ 3 MINUTES
        MAX.INBALANCE ............ 2 TUBES
        SPEED .................... UP TO 4000RPM
        RCF ...................... 2000 AT 4000RPM
    BECKMAN INSTRUMENTS            #152                 $245
        SPINNING RATE.................... 0 TO 16000 RPM
        ACCOMODATION .................... .4ML TUBES(20)
        DIMENSIONS . .................... 9X7X7 INCHES
        WEIGHT ..... .................... 13 LBS(SHIPPING)
        POWER ........................... 115V 50/60 HZ
        DEVELOPED G ..................... 13000

410000 PRESSURE TANK                                       ST098   41111
410000
410000 PROVIDE PRESSURE SOURCE FOR WATER FEED SYSTEM TO STEAM GENERATOR
410000 EXPERIMENT
410000
410000    OPERATING PRESSURE............ 100 PSI(6.9X10E5 N/M**2)
410000
410000 WATER RESERVOIR WITH HEATER                         ST099   11113
410000
410000 STORE WATER FOR STEAM GENERATOR EXPERIMENT
410000
410000    OPERATING PRESSURE............ 30PSI(2.07X10E5 N/M**2)
410000
415500 PUMP                                                ST100   11111
415500
415500 PUMP WATER TO STEAM GENERATOR
415500
415500    FLOW RATE..................... 0.1 LB/HR (0.045KG/MIN)
415500
211000 STEAM GENERATOR                                     ST101   11135
211000
211000 DEVICE TO GENERATE STEAM IN ZERO GRAVITY
211000
004100 AIR SAMPLE UNIT                                     ST105   21111
004100
004100 PERIODIC COLLECTION OF AIR SAMPLES FROM THE SHUTTLE AND ATL
004100 PROVIDING TYPE, RATE OF CHANGE AND QUALIFICATION OF MICRO-
004100 ORGANISMS AND NON-VIABLE PARTICLES.  USED ON ST01S AND ST03S.
004100
    BAUSCH - LOMB INC.             #40-1A                            111
        SAMPLING RATE ............ 0.1 CU.FT./100SEC.
                                   (0.17 LITERS/MIN.)
        MAX.CONCENTRATION MEAS ...  1E+7 PARTICLES/CU.FT.
                                     (35E+3 PARTICLES/LITER)
        PARTICLE SIZE RANGE ...... 0.3,0.5,1.0,2.0,3.0,5.0,10MICRONS
498500 TIMER                                               ST107   11111
498500
498500 TIMING AND VARIABLE PROGRAMMING CAPABILITY TO OPERATE AND CONTROL
498500 EXPERIMENT AND SUPPORTING EQUIPMENT.  USED IN ST01S AND ST03S.
498500
    ROHDE AND SCHWARZ              #CAD (100.6597.91)    $5400
        DISPLAY ......................... 6 DIGITS: HR, MIN, SEC
        OUTPUT .......................... 1-OUT-OF-N AND/OR BCD CODE
        PROGRAMMER.......................TIME PROGRAMS(COUNT
                                         DOWN) AND TIME SIGNALS
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   DATATRON                          #3350-506          $1170
        INPUT FREQUENCY................. 60HZ
        OUTPUTS......................... VISUAL,BCD
        DISPLAY......................... HRS,MIN,SEC

   TENNELEC                          #TC545               $550
        COUNT RATE...................... 20MHZ
        TIMEBASE........................ 0.1 OR 0.01SEC
        ACCURACY........................ SAME AS LINE FREQUENCY
        CONFIGURATION................... NIM COMPATIBLE

187000 WORK BENCH                                        ST142    $1114
187000
187000 PROVIDE A WORK AREA UPON WHICH EXPERIMENTS AND MAINTENANCE MAY BE
187000 PERFORMED.  ENCLOSED STORAGE TO BE INCORPORATED IN BENCH.  USED
187000 ON ST01S, ST02S, ST03S, ST04S AND ST06S.
187000
187000     SIZE APPROXIMATELY ........... 2X3X4 FT (0.61X0.91X1.2 M)
187000
424000 TAPE RECORDER, ANALOG                             ST007    $1111
424000
424000 RECORD VOICE, FM AND VIDEO DATA OF LANDMARK AND STAR-TRACKING
424000 FIELDS. USED IN ST02S, ST03S AND ST05S.
424000
424000     BANDWIDTH ...................... TO 2.5 MHZ
424000     RECORDING FORMAT ...................... VOICE, FM AND VIDEO
424000     CHANNELS ....................... 7
424000
   AMPEX CORPORATION                 #AR-200                            121

        BANDWIDTH ...................... 100 HZ TO 3125 HZ THROUGH
                                         300 HZ TO 250 KHZ
        TAPE WIDTH ..................... 0.5 INCH
        TAPE SPEED ..................... 1.875 TO 60 IPS
        RECORDING TIME ................. 8 MINUTES TO 4 HRS AND 16 MINS
        FORMAT ......................... DIGITAL
        TRACKS ......................... 8 DIGITAL, 7 ANALOG

   AMPEX CORP                        #AR 1700           $28,000         112
        TRACKS ......................... 14
        TAPE SPEED ..................... 120 IPS
        TAPE WIDTH ..................... 1 INCH
        RECORDING MODE.................. DIRECT
        PACKING DENSITY ................ 20 KB/I/T
        SIGNAL/NOISE ................... 20 DB
        DATA CAPACITY .................. 6.2E+10
        BANDWIDTH ...................... 2 MB/SEC/T

   SANGAMO ELECTRIC                  #SABER III         $26,500         111
        TRACKS ......................... 14
        TAPE WIDTH ..................... 1 INCH
        TAPE SPEEDS..................... 8 SELECTABLE SPEEDS FROM 15/16
                                         TO 120 IPS
        FREQUENCY RESPONSE ............. 400 HZ TO 2.0 MHZ
        RECORDING RATE ................. 600 KBPS AT 120 IPS SERIAL MODE
        WEIGHT ......................... 100 POUNDS

   DIGI-DATA CORPORATION             #1600              $2650           111
        TAPE SPEED ..................... 25, 18.75, 12.5 IPS
        TRACKS ......................... 7 OR 9 TRACK
        DATA DENSITY ................... 1600 CPI PHASE ENCODED
                                         200, 556, 800 CPI NRZI
        TAPE ........................... 0.5 INCH, 1.5 MIL, 1200 FEET

   DIGI-DATA CORPORATION             #1700/PDP-11/7-9   $5250           111
                                      TRACK NRZI
        TAPE SPEED ..................... 45, 37.5, 25, 18.75, 12.5 IPS
        TAPE ........................... 0.5 INCH, 1.5 MIL, IBM/ANSI
                                         COMPATIBLE, 10.5 INCH REEL
        TRACKS ......................... 7 OR 9
        DATA DENSITY ................... PHASE ENCODED
                                         COMPATIBLE

   HEWLETT PACKARD                   #79708/C           $ 4600          111
        TAPE FORMAT .................... 800, 556, OR 200 CPI NRZI AND
                                         1600 CPI PHASE-ENCODED
        CHANNELS ....................... 7 OR 9
        TAPE SPEED ..................... 10 TO 45 IPS
        TAPE ........................... 0.5 INCH, 1.5 MILS, IBM/ANSI
                                         COMPATIBLE

   BORG WARNER                       #PERT                              121
        TRACKS ......................... 30
        TAPE SPEED ..................... UP TO 1000 IPS
        TAPE WIDTH ..................... 1/2 INCH
        TAPE LENGTH .................... 2400 FEET
        PACKING DENSITY ................ 15 KB/I/T
        SIGNAL/NOISE ................... 24 DB
        DATA CAPACITY .................. 1.3E+9
        BANDWIDTH ...................... 6-15 MB/SEC/T

   LEACH                             #MTR 7000                          311
        TRACKS ......................... 12
        TAPE SPEED ..................... 120 IPS
        TAPE WIDTH ..................... 1 INCH
        TAPE LENGTH..................... 4200 FEET
        PACKING DENSITY................. 16.7 KB/I/T
        SIGNAL/NOISE ................... 22 DB
        DATA CAPACITY .................. 2.2E+10
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    BANDWIDTH ........................ 2 MB/SEC/T

HEWLETT PACKARD              #3955D              $10200        111
    BANDWIDTH ........................ 300 KHZ
    CHANNELS ......................... 7
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD              #3955C              $14700        111
    BANDWIDTH ........................ 300 KHZ
    CHANNELS ......................... 14
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD              #3950A-C11          $23800        111
    BANDWIDTH ........................ 500 HZ TO 2 MHZ
    CHANNELS ......................... 14
    RECORDING FORMAT ................. DIRECT OR FM

HEWLETT PACKARD              #3960A/13065A/13063A $4796        111
    CONFIGURATION .................... RACK MOUNTED
    TAPE SPEED ....................... 15, 3 AND 3/4, 15/16 IPS
    CHANNELS ......................... 4
    RECORDING FORMAT ................. FM
    PASSBAND ......................... 5 KHZ
    S/N RATIO......................... 48 DB
    TRACKS ........................... 30

HONEYWELL                    #5600               $9730
    PORTABLE TAPE RECORDER
    CHANNELS.......................... 7
    SELECTABLE TAPE SPEED RANGE...... 15/16 TO 60IPS
    MAXIMUM BANDWIDTH(DIRECT)........ 300KHZ
    PACKING DENSITY.................. UP TO 600PBI
    WEIGHT........................... 70LBS (32KG)
    INPUT VOLTAGE....................28VDC

HONEYWELL                    #96                 $17420
    CHANNELS.......................... 7
    SELECTABLE TAPE SPEED RANGE...... 15/16 TO 240IPS
    REEL SIZE........................ 16IN
    MAXIMUM BANDWIDTH(DIRECT)........ 2M HZ
    TAPE WIDTH....................... 1/2 IN

AMPEX CORP                   #AR 70C             $29,180       511
    TRACKS ........................... 14
    TAPE SPEED ....................... 60 IPS
    TAPE WIDTH ....................... 1 INCH
    RECORD MODE....................... DIRECT
    PACKING DENSITY .................. 20 KB/I/T
    SIGNAL/NOISE ..................... 20 DB
    DATA CAPACITY .................... 8E+10 BITS
    BANDWIDTH ........................ 1 MB/SEC/T

227000 LASER                                               ST118   11111
227000
227000 MODE-LOCKED LASER RANGING SYSTEM MEASURING RANGE, LINE-OF-SIGHT
227000 ANGLES, AND RANGE RATE BETWEEN ATL/SHUTTLE AND SEPARATE SPACE
227000 VEHICLES INCLUDING RANGE OF ATL TO GROUND.
227000
227000    RANGE TOLERANGE .............. +/- 1.18 IN (+/-3 CM) ATL-GND
227000    COOPERATIVE TARGET DISTANCE .. 300 NM (556 KM)
227000

610015 RECEIVER - RF                                       ST127   11111
610015
610015 MEASURE ELECTROMAGNETIC INTERFERENCE AT ORBITAL ALTITUDES IN THE
610015 FREQUENCY SPECTRUM OF 400 MHZ TO 15 GHZ. USED ON ST025 AND ST035.
610015
610015    OVERALL SPECTRUM ............. 400 MHZ TO 15 GHZ
610015    SPECIFIC MULTIPATH MEASURE.... 1.5 TO 1.6 GHZ
610015                                   2.025 TO 2.3 GHZ
610015                                   13.4 TO 15.35 GHZ
610015
    SINGER                   #NM 37/57           $13,500
       FREQUENCY RANGE....................30 TO 1000 MHZ IN 8 BANDS
       ACCURACY...........................+/- 2 % FREQUENCY, +/- 3%
                                          VOLTAGE
       VOLTAGE MEAS. RANGE................600B METER SCALE + 20,40,
                                          60,80 DB ATTENUATER STEPS
                                          TOTAL 1400B
       DETECTOR FUNCTIONS.................FIELD INTENSITY,QUASI-PEAK,
                                          DIRECT PEAK,SLIDEBACK PEAK,
                                          BFO,FM DISCRIMINATOR,LINEAR

010700 TELESCOPE - POINTING                                ST152   11133
010700
010700 POINTING TELESCOPE WHICH ALLOWS EXPERIMENT PHENOMENA TO BE
010700 OBSERVED AND TRACKED IN SPACE
010700
407000 POWER SUPPLY                                        ST171   21111
407000
407000 ELECTRICAL POWER REGULATION AND DISTRIBUTION AS REQUIRED AND AT
407000 VARIABLE VOLTAGE RANGES.  USED IN ST025, ST035 AND ST045.
407000
407000    VOLTAGE ............................ 0 TO 24 VDC
407000    POWER .............................. 200 WATTS
407000    SENSITIVITY ........................ 0.09 VOLT
407000
   POWER DESIGNS INC.        #APC-320            $275
      OUTPUT ......................... +/-12VDC A+ 0-2AMP
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        ........................... +/-24VDC AT 0-1AMP
    REGULATION ..................... +/- 0.05 %
    IMPEDANCE ...................... <0.3 OHM UP +0 150 KHZ
    DIMENSIONS...................... 17X3-1/2X5-1/2 INCHES
    WEIGHT ..........................16.5 LB
ROHDE AND SCHWARZ          #NGRE (100.8254.14) $1500        111
    VOLTAGE ........................ 0 TO 30 V
    CURRENT ........................ 0 TO 10 A

JOHN FLUKE MFG CO INC      #4250A              $1795        111
    PROG CODING .................... BCD (BINARY AVAILABLE)
    OUTPUT VOLTS ................... 0 TO +/- 65 VOLTS DC/PEAK AC
    OUTPUT CURRENT ................. 1 AMP
    FREQUENCY RANGE ................ DC TO 30 KHZ
    RESOLUTION ..................... 1 MV
    REGULATION ..................... 0.001%

JOHN FLUKE MFG CO INC      #382A               $1795        111
    OUTPUT VOLTAGE ................. 0 TO 50 VDC, 0 TO 5 VDC
    OUTPUT CURRENT ................. 0 TO 2 AMPS
    REGULATION ..................... 0.0005%
    STABILITY ...................... +/- 0.0025% PER DAY

SORENSEN                   #SRL40-12           $550         111
    OUTPUT VOLTAGE.................. 0 TO 40 VOLTS
    OUTPUT CURRENT(MAX)............. 12AMPS
    REGULATION...................... +/-.01% OR +/-2MV
    CONFIGURATION................... RACK MOUNT
    SIZE............................ 51/4X19X15 1/8IN
    WEIGHT.......................... 64LB (30KG)
    COOLING......................... NATURAL CONVECTION


SORENSEN                   #MOB 72-2C          $450         311
    NIM COMPATIBLE POWER SUPPLY
    OUTPUT VOLTAGES................. +/-12V; +/-24V
    OUTPUT CURRENT.................. 2ADC; 1ADC
    REGULATION...................... +/-0.05%
    CONFIGURATION................... MOUNTS TO BACK OF NIM BIN
    SIZE............................ 16.825X3.438X5.5IN
    WEIGHT.......................... 11.5LBS(5.2KG)

AYDIN CORP, VECTOR DIV.    MODEL TV-64         $325         111
    INPUT POWER                      30MA AT 29VDC
    INPUT VOLTAGE RANGE              28+/-4VDC
    OUTPUT REGULATION                0.25%
    OUTPUT RIPPLE                    LESS THAN 5MVP-P
    OUTPUT CURRENT                   +/-22VDC AT 100MA EA.
MODULAR POWER INC.         #T-27                $129
    OUTPUTS ........................ 4
    POWER OUTPUT ................... 2 TO 50 VOLTS, 1 TO 10 AMPS
    AC INPUT @ 50/1000 HZ .......... 105/125 OR 210/250 VAC
    RIPPLE OUTPUT .................. 500 MICROVOLTS (RMS)
    WEIGHT ......................... 8.5 LBS.
    SIZE (WXHD) .................... 4.25 X 5.5 X 3.63 INCHES
    TEMPERATURE BASE ............... 71 DEG C

TENNELEC                   #TC911               $275        111
    INPUT VOLTAGE................... 103 TO 129VAC 50 TO 60HZ
                                     208 TO 258VAC 50 TO 60HZ
    OUTPUT.......................... +/-24VDC AT 1AMP
                                     +/-12VDC AT 2AMP

424100 RECORDER, OPTICAL                                ST273   11235
424100
424100 RECORD AND PLAYBACK DIGITALLY GENERATED DATA FROM A LASER SYSTEM.
424100 USED ON ST025 AND ST035.
424100
424100    BANDWIDTH ..................... TO 50 MHZ
424100    SIGNAL ........................ DIGITAL
424100    CHANNELS ...................... 3
424100
    HRB SINGER INC.        #HMD-7                           115
    FILM SIZE ...................... 5 IN.
    FILM LENGTH .................... 250FT.
    RESOLUTION ..................... 4500 LINES/TRACK
                                     (2250 LINE PAIRS)
    FILM SPEED ..................... 17 FT/MIN.
    DATA RECORD .................... DATA CARD,HACK CLOCK,COUNTER,C
                                     FIDUCIAL MARK
    FILM TRANSPORT SPEED ........... UP TO 200 IN./MIN. FUNCTION V/H
                                     RATIO

RESALAB SCIENTIFIC         #WIDEBAND DIG.REC./REPRODUCE     212
    DATA RATE ...................... 85 MEGABITS/SEC.
    CHANNEL BANDWIDTH .............. 100MHZ/CHANNEL
    RECORD METHOD .................. MULTILASER
    INTERNAL DIGITAL DATA RATE ..... 22 MEGABITS/SEC.
    FILM RATE ...................... 100FT/MIN
    FILM CAPACITY .................. 4000 FT
    NUMBER RECORD TRACKS ........... 4
    FILM SIZE ...................... 70MM
    CONTRAST RATIO ................. 100:1

179500 FREQUENCY METER                                  ST156   11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD, AVERAGE RATIO AND
179500 MULTIPLE RATIO OF VHF FREQUENCY SOURCES.  USED ON ST035.
179500
179500    BANDWIDTH ......................... 10 TO 100 MHZ
179500    SENSITIVITY ................... +/- 2 %
179500
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JOHN FLUKE MFG CO INC           #1952A-C7              $995          111
     FREQUENCY RANGE ................. DC TO 515 MHZ
     DISPLAY ......................... 7 DIGIT LED (8 OR 9 OPTICAL)
     SENSITIVITY ..................... 50 MV RMS
     PERIOD RANGE .................... DC TO 10 MHZ (DC COUPLED)
                                       5 HZ TO 10 MHZ (AC COUPLED)
     TIME INTERVAL RANGE ............. 0.1 MICROSEC TO 1E+6 SEC

ROHDE AND SCHWARZ               #FET2(100.6039.02/                   111
                                      110.6125.02/
                                      100.P003.02/
                                      100.A051.02/
                                      100.6068.02)
     FREQUENCY RANGE ................. 0 - 100 MHZ
     SENSITIVITY ..................... -5 TO +5 VOLTS
     PERIOD RANGE .................... 0.5 MICROSEC TO 100 SEC
     TIME INTERVAL RANGE ............. 0.2 MICROSEC TO 1E+6 SEC

480000 CAMERA, TV                                          ST025   31131
480000
480000 REAL-TIME VIEWING OF TARGET AREAS, LAND MARK AND STAR FIELD
480000 TRACKING, AND SENSOR BORESIGHTING.
480000 USED ON ST045, ST055 AND ST065.
480000
480000     VIEW ANGLE ......................... 8 TO 10 DEGREES
480000     RESOLUTION ......................... 1025 LINES
480000
   RCA ELECTRONICS COMPONENTS    #8521                 $520          111
     TYPE ............................ VIDICON-SULFIDE
     PHOTOCONDUCTER .................. II
     IMAGE DIAGONAL .................. 25 MM, (1 IN)

     FOCUS ........................... MANUAL
     LIMITING RESOLUTION.............. 1500 LINES

   COHU INC. ELECTRONICS DIV.    #1220                 $8430         111
     IMAGE CONVERTER ................. 4846B VIDICON - COLOR
     RESOLUTION-HORIZONTAL LIMIT ..... 300 LINES MIN.
     GEOMETRIC DISTORTION ............ < 2 % OF PIC HEIGHT
     LENS MOUNT ...................... 16 MM - C-MOUNT

   COHU INC. ELECTRONICS DIV.    #2000                 $3300         311
     LENS-BUILTIN .................... 4:1 (20-80 MM) F/2.5 ZOOM
     LENS ATTACHMENT ................. 4:1 (12.5-80 MM)
     LENS INTERCHANGEABLE ............ 10:1 (15-150 MM) F/2.8 ZOOM
                          ............ 16 MM C-MOUNT FFL
     10 MHZ BANDWIDTH (MOD 2006) ..... 525 OR 729 LINE (VIDICON 7263A)
     20 MHZ BANDWIDTH (MOD 2004) ..... 873 OR 945 LINE (VIDICON 8573)
     MIL SPECIFICATIONS .............. MIL-E-5272C, MIL-STD-810

   COHU INC. ELECTRONICS DIVISION#4500                 $2225         311
     LENS ............................ 4:1 ZOOM
          ............................ 10:1ZOOM
     VERTICLE SWEEP RATE ............. 60FIELDS PER SEC
     HORIZONTAL SWEEP RATE ........... 525 LINES PER FRAME
     IMAGE TUBE TYPE ................. 8541A STD
     LENS MOUNT                        16 MM C-MOUNT
     MIL SPECIFICATIONS .............. MIL-E-5400M, MIL-E-5300M
499605 MASS SPECTROMETER                                   ST163   11111
499605
499605 ANALYSIS OF GASEOUS COMBUSTION PRODUCTS FORMED IN ZERO GRAVITY
499605 VIA MASS SPECTROSCOPY.  USED IN ST045 AND ST068.
499605
499605     MASS RANGE ...................... 1 TO 1000 AMU
499605     SCANNING RATE ................... 60 MSEC TO 600 SEC
499605     SENSITIVITY ..................... 1 %
499605
   EXTRANUCLEAR LABORATORIES     #279-7                $33900        111
     MASS RANGE....................... 2 TO 1000 AMU
     RESOLUTION....................... GREATER THAN UNIT TO MASS 1000
     SENSITIVITY...................... EX: .075 NG/SEC METHYL STEARATE
     ACCESSORIES......................  GC INTERFACES.PROBES.HEATER.ECT

   VEECO INSTRUMENTS INC         #GA-4-EM              $9495         111
     MASS RANGE....................... 1 TO 760 AMU
     RESOLUTION....................... RESOLVES TWO MASSES .0256 APART
     SENSITIVITY...................... 1XE-13 TORR FOR N2
     RECORDER......................... 3DECADES ON SINGLE CHART
     SCAN RATES....................... VERY SLOW TO FAST

074700 GAS CHROMATOGRAPH                                   ST175   21111
074700
074700 ANALYSIS OF COMBUSTION PRODUCTS FOR FLAME CHEMISTRY EXPERIMENTS.
074700 USED IN ST045 AND ST065.
074700
   BECKMAN                       #GC-2A                $2050         111
     DETECTOR ........................ THERMAL CONDUCTIVITY
     TEMPERATURE CONTROL RANGE ....... 40C TO 240C
     CONTROL ACCURACY ................ +/-0.1

   BECKMAN INSTRUMENTS           #6700                 $8000
     SENSITIVITY......................1 +0 5 PPM
     OPERATING TEMP...................55 +C 225C
     TEMPERATURE CONTROL..............+/- 0.05C

   BECKMAN INSTRUMENTS           #6700                 $8000
     SENSITIVITY......................1 +0 5 PPM
     OPERATING TEMP...................55 +C 225C
     TEMPERATURE CONTROL..............+/- 0.05C
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    CARLE INSTRUMENTS, INC.        #AGC-311                 $2675
        CONTROL SENSITIVITY ............. < 0.001 DEG C
        TEMPERATURE RANGE ............... TO 355 DEG C (1 DEG INCREMENTS)
        HEAT CAPACITY-TOTAL ............. 600 WATTS
        INLETS .......................... DUAL ON-COLUMN
        IONIZATION DETECTORS ............ HYDROGEN FLAME
        VALVING ......................... MICRO OR MINI VOLUME VALVES
        WEIGHT........................... 53 POUNDS
        POWER REQUIREMENTS .............. 115 VAC

    CARLE INSTRUMENTS, INC.        #9500                    $1185
        TEMPERATURE RANGE ............... AMBIENT TO 200 DEG C
        DETECTOR ........................ DUEL FEED SINGLE HYDROGEN FLAME
        SENSITIVITY ..................... 5E-12 AMPERES
      POWER REQUIREMENTS ............... 115 VAC, 50 TO 60 HZ

419500 PYROMETER                                                ST176   11111
419500
419500 MEASURE TEMPERATURE OF COMBUSTION PROCESS IN FLAME CHEMISTRY
419500 EXPERIMENTS.  USED IN ST045 AND ST065
419500
419500    TEMPERATURE RANGE ...................... 0 TO 3000 DEG F
419500
    IRCON                          #2000                    $2400          111
        TEMPERATURE RANGE ............... 40 - 3000 DEG C
        SPECTRAL RESPONSE ............... 0.70 TO 0.97 MICRON
        CALIBRATION ACCURACY ............ +/- 1 PCT FS TEMP OR +/-5 DEG C
        REPEATABILITY ................... +/- 0.3 PCT FS TEMP
        RESPONSE TIME AT METERS ......... 95 PCT FS INPUT WITHIN 1 SEC
        INDICATOR/CONTROLLER AMB TEMP .. 10 TO 65 DEG C
        SENSING HEAD AMBIENT TEMP ....... -32 TO 94 DEG C

098500 COMBUSTION CHAMBER                                       ST178   11135
098500
098500 CHAMBER WHERE FUELS AND OXIDIZERS ARE INJECTED, ALLOWED TO BURN
098500 AND THE FLAME CAPABLE OF BEING MONITORED.
098500
098500    SIZE APPROXIMATELY ............ 1.67 DIA X 3.5 FT
098500                                    (0.51 DIA X 1.0 M)
098500
410000 TANKS - FUEL/OXIDIZER                                    ST179   41135
410000
410000 SIMILAR TYPE TANKS CAPABLE OF STORING CORROSIVE FUELS AND
410000 OXIDIZERS IN THE SORTIE LABORATORY AT LOW PRESSURES.  USED IN
410000 ST045 AND ST065.
410000
410000    SIZE APPROXIMATELY ............ 0.75 DIA X 3 FT
410000                                    (0.225 DIA X 0.9 M)
410000
297500 CHAMBER, CUBICAL TEST                                    ST188   11135
297500
297500 CHAMBER FOR PERFORMANCE OF SUPERFLUID HELIUM AND LIQUID DROP/
297500 PARTICLE EXPERIMENTS
297500
297500    DIMENSIONS......................1.8FT(0.55M)CUBE
297500
003110 ACOUSTIC SPEAKER                                         ST189   61111
003110
003110 PARTICLE POSITIONING DRIVER
003110
003110    FREQUENCY RANGE................ 50 TO 10KHZ
003110
238500 MAGNET, SUPERCONDUCTING                                  ST190   11112
238500
238500 MAGNET FOR DROP/PARTICLE POSITIONING
238500
286000 MOTOR,ELECTRIC                                           ST191   11111
286000
286000 MOTOR FOR CHAMBER DRIVE SYSTEM
286000
108600 CRYOSTAT - HELIUM                                        SY192   11113
108600
108600 DEWAR TYPE STORAGE CONTAINER TO STORE AND DISPENSE LIQUID HELIUM.
108600
108600    SIZE APPROXIMATELY ............ 1.5 DIA X 1.7 FT
108600                                    (0.5 DIA X 0.05 M)
108600
    CRYOGENIC ASSOCIATES INC       #SD-15                   $2852          112
        DEWAR DIA. ...................... 17 IN.
        LIQUID HELIUM CAP. .............. 101 LITERS
        LIQUID NITROGEN CAP. ............ 26.5 LITERS

    UNION CARBIDE (LINDE DIV.)     #G304-CC52(PART NO)  $1150          111
        CAPACITY LIQ HE.................. 30 LITERS
        EVAP RATE/DAY ................... .8%
        DIMENSIONS ...................... 44X18.75 INCHES
        WEIGHT .......................... 93 LB(MT) 91.4LB(FULL)

526200 PRESSURE MONITOR                                         ST193   11114
526200
526200 MEASURES PRESSURE IN TEST CHAMBER AND DISPLAYS DIGITALLY
526200
487000 TEMPERATURE MONITOR                                      ST194   11114
487000
487000 MONITORS AND CONTROLS TEST CHAMBER TEMPERATURE
487000
098500 COMBUSTION CHAMBER                                       ST202   11135
098500
098500 CHAMBER TO EXAMINE COMBUSTION IN ZERO GRAVITY
098500
098500    DIMENSIONS..................... 1.67FT(0.51M)DIA.X4.0FT(1.22M)
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OF POOR QUALITY

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098500
499605 ELECTRCN SPIN RESONANCE/MASS SPECTROMETER          ST258   11112
499605
499605 IDENTIFY CONSTITUENTS OF COMBUSTICN PRODUCTS
499605
414500 TEMPERATURE SENSORS                                ST260   11111
414500
414500 SENSOR TO MEASURE TEMPERATURE OF COMBUSTION PROCESS
414500
414500    TEMPERATURE RANGE(EST)....... 1000 TO 3000F
414506
524500 PRESSURE SENSORS                                   ST260   11111
524500
524500 SENSORS TO MEASURE PRESSURE OF COMBUSTION EXPERIMENT
524500
524500    PRESSURE RANGE................. TBD
524500
410000 OXIDIZER TANK                                      ST262   11135
410000
410000 STORE OXIDIZER FOR COMBUSTION REACTION
410000
410000    VOLUME......................... 2 CU.FT. (0.55 CU.M.)
410000
410000 FUEL TANK                                          ST261   11135
410000
410000 STORE FUEL FOR COMBUSTION EXPERIMENT
410000
410000    VOLUME......................... 2 CU.FT. (0.055 CU.M.)
410000
410300 INERT GAS SUPPLY                                   ST263   11111
410000
410000 SUPPLY PRESSURE FOR EXPULSION OF FUEL AND OXIDIZER FRCM STORAGE
410000 TANKS
410000
410000    VOLUME ........................ 0.22 CU.FT.(0.006 CU.M)
410000
234000 STROBE LAMP                                        ST157   11111
234000
234000 VARIABLE DISCHARGING STROBE LIGHTS WHICH ALLOW THE STOPPING OF
234000 MCTION.
234000
234000    STRCBE DISCHARGE RATE ......... 1 TC 1000 FLASHES/SEC
234000
    GRANVILLE PHILLIPS            #SPECTRASCAN 400    $7000
       MASS RANGE ..................... 1 TO 400AMU IN ONE RANGE
       SCAN RATE ...................... VARIABLE 30MILLISECCNDS TC 600
                                         SECONDS/SCAN
       SENSITIVITY .................... 50 AMP/TORR FOR N2 AT M/AM=42

631001 CRITICAL STATE TEST CELL                           ST207   11235
631001
631001 TEST CELL TO TEST CRITICAL POINT PHENOMENA. TEST CELL INCLUDES
631001 A THERMAL SHIELD, HEAT EXCHANGER, MICROMETER, CHAMBER, SUPPORT
631001 ELECTRONICS AND   PRESSURE TRANSDUCERS
631001
003210 ACOUSTIC MEASUREMENT DEVICE                        ST214   11114
003210
003210 DEVICE CONSISTS OF AN ACOUSTIC CAVITY, AN OSCILLATOR AND A
003210 DIGITAL DISPLAY
003210
631002 POOL BOILING TEST CHAMBER                          ST218   21235
631002
631002 CHAMBER TO EVALUATE POOL BOILING PHENOMENA IN ZERO GRAVITY
631002
414500 INSTRUMENTATION SENSOR SYSTEM                      ST223   11114
414500
414500 SYSTEM INCLUDE TEMPERATURE, PRESSURE AND ACCELEROMETER SENSCRS
414500
631003 CRYSTALIZER SAMPLE CHAMBER                         ST225   11135
631003
631003 CHAMBER FOR GROWING CRYSTALS IN ZERO G
631003
631004 SCHLIEREN TYPE OPTICS SYSTEM                       ST227   11135
631004
631004 OPTICS SYSTEM EMPLOYING SCHLIEREN METHOD TO EXAMINE THE STRUCTURE
631004 OF CRYSTALS
631004
631005 HCLOGRAPHIC INTERFERCMETER                         ST231   11235
631005
631005 DEVICE TO EXAMINE STRUCTURE OF GRCWING CRYSTALS
631005
    OPTICS TECHNOLOGY INC         #215              $1995           111
       POWER LEVEL..................... 0.3 TO 1.0MW:   1.0 TC 2.0MW
       EXPOSURE TIME...................45 TO 180 SEC:  15 TC 60 SEC
       MOUNT........................... BENCH
       FILM PLATE SIZE................. 4 X 5IN
       HOLOGRAM TYPES.................. GABOR AND FRESNEL

    JCDCA ENGR ASSOC              #HS-2             $8700           111
       ACTIVE VIBRATION ISOLATION
       LASER........................... 20MW HE NE
       SYSTEM COMPONENTS............... REAL TIME PLATE HOLDER, SHUTTER
                                        BEAM STEERER, REFERENCE MIRRORS
                                        SPATIAL FILTERS, VARIABLE BEAM
                                        SPLITTER, ENCLOSURE

    JCDCA ENGR ASSOC              #AP-10C AUTO      $6500
                                   PHOTO PROCESSOR
       PROVIDES CHEMICAL FILLING AND CIRCULATING, AND DRAINING TO
       PROCESS PHOTOGRAPHIC PLATE

001000 ACCELEROMETER,TRIAXIAL                             ST235   21111
001000
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       COMMUNICATIONS AND NAVIGATION

620001 TRACKING ANTENNA SERVO ELECTRONICS                      CNC44    11114
620001
620001 ELECTRONICS FOR ANTENNA POSITIONING AND CONTROL
620001
620001    TYPE ......................... TYPE II SERVO LOOP
620001    GAIN CONSTANT ................ 3.5E4 PER SEC SQUARED
620001    BANDWIDTH .................... 100 HZ
620001
618030 RECEIVER, L BAND                                        CN045    21111
618030
618030 RECEIVE L BAND SIGNALS TO DEMONSTRATE THE OPERATIONAL PERFORMANCE
618030 OF TYPICAL SPACEBORNE INTERFEROMETERS FOR AIRCRAFT AND MARINE
618030 NAVIGATION/TRAFFIC CONTROL. TRACK SIGNAL PHASE.
618030
618030    CARRIER FREQUENCY ............ 1569.75 TO 1570.25 MHZ
618030    SENSITIVITY .................. -120 DBM
618030    RECEIVER TYPE ................ PHASE LOCK, SUPERHETERODYNE,
618030                                   FIXED FREQUENCY, AGC
618030    DYNAMIC RANGE ................ 40 DB INSTANTANEOUS
618030                                   100 DB TOTAL
618030    PRE-DETECTION BW ............. 5 MHZ
618030    SWEEP RATE ................... TUNE 3 PPM OF CARRIER FREQ
618030    PHASE LOCK LOOP SNR .......... 40 DB
618030    RECEIVER NOISE FIGURE ........ 5 DB
618030    PHASE LOCK LOOP BANDWIDTH .... 10 HZ
618030
    RHG ELECTRONICS LAB INC        #FMR W1900ATR        $9000          211
        FREQUENCY .................... 1.4 TO 2.3 GHZ FIXED TUNED
        IF/DISCRIMINATOR BW .......... 50 MHZ
        NOISE FIGURE ................. 11 DB

618050 RECEIVER, VHF                                           CN046    51111
618050
618050 RECEIVE VHF SIGNALS FOR DETAILED EVALUATION OF PERFORMANCE CHAR-
618050 ACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK. PROVIDES NUMBER OF
618050 RECEIVER FRONT ENDS WHICH CAN BE CONNECTED IN DIFFERENT RECEIVE
618050 CONFIGURATIONS.
618050
618050    CARRIER FREQUENCY ............ 126 TO 130 MHZ
618050    SENSITIVITY .................. +/- 25 MHZ
618050    CARRIER/NOISE DENSITY RATIO .. 53 DBW
618050    DATA RATE .................... 100 TO 1000 BPS
618050
    ECI                            #976                                112

    ROHDE AND SCHWARZ              #ESG (100.1472.02)   $16,625        111
        FREQUENCY RANGE .............. 30 TO 330 MHZ
        INPUT VOLTAGE ................ 1 MICROVOLT TO 0.1 VOLT
        NOISE FIGURE ................. 10 TO 13 DB
        OUTPUT ....................... 2XIF, 2XAF, RECORDER

618020 RECEIVER, KU-BAND                                       CN047    11235
618020
618020 RECEIVE KU BAND SIGNAL FOR DETAILED EVALUATION OF PERFORMANCE
618020 CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.
618020
618020    CARRIER FREQUENCY ............ 13.4 TO 14.2 GHZ
618020    SENSITIVITY .................. +/- 25 MHZ
618020    CARRIER/NOISE DENSITY RATIO .. 96 DB/HZ
618020    DATA RATE .................... 100 TO 1000 BPS
618020                                   DATA UP TO VIDEO
618020
618060 RECEIVER, S-BAND                                        CN048    11111
618060
618060 RECEIVE S BAND SIGNAL FOR DETAILED EVALUATION OF PERFORMANCE
618060 CHARACTERISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.
618060
618060    CARRIER FREQUENCY ............ 2025 TO 2120 MHZ
618060    SENSITIVITY .................. +/- 25 MHZ
618060    CARRIER/NOISE DENSITY RATIO .. 85 DB/HZ
618060    DATA RATE .................... 100 TO 1000 BPS
618060                                   VOICE
618060
    ROHDE AND SCHWARZ              #USU3 (100.1608.02/  $10,160        111
                                     100.1614.02)
        FREQUENCY RANGE .............. 2 TO 5.1 GHZ
        VOLTAGE RANGE ................ 25 MICROVOLT TO 80 MILLIVOLT
        NOISE VOLTAGE ................ <3.5 MICROVOLT
        IMAGE FREQUENCY REJECTION .... 30 TO 40 DB
        OUTPUT ....................... 2XIF, 2XAF, RECORDER

    RHG ELECTRONICS LAB INC        #FMR W19CCATR        $9000          211
        FREQUENCY .................... 1.4 TO 2.3 GHZ FIXED TUNED
        IF/DISCRIMINATOR BW .......... 50 MHZ
        NOISE FIGURE ................. 11 DB

618070 RECEIVER, LASER ELECTRONICS                             CN049    11235
618070
618070 PERFORMS DATA DEFORMATTING FROM LASER CARRIER BEAM
618070
620030 TRANSMITTER, VHF                                        CN050    11111
620030
620030 PROVIDES MEDIUM POWER OUTPUT FOR TRANSMISSION TO TDRS FOR EVAL-
620030 UATION OF PERFORMANCE CHARACTERISTICS.
620030
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620030    CARRIER FREQUENCY ............. 136 TO 144 MHZ
620030    STABILITY ..................... +/- 20 KHZ
620030    OUTPUT POWER .................. 10 WATTS MAX
620030    DATA RATE ..................... 100 TO 10,000 BPS
620030    SIGNAL BANDWIDTH .............. 0.1 MHZ
620030    DUTY CYCLE .................... CONTINUOUS
620030
     ECI                         #935                           112
          FREQUENCY ..................... 290 TO 315 MHZ
          POWER OUTPUT .................. 60 WATTS
          BANDWIDTH ..................... UP TO 10 MHZ
          SPURIOUS OUTPUTS .............. > 80 DB DOWN

     AYCIN CO.,VECTOR DIV        TM-1225          $945          122
          POWER OUTPUT                    0.3 WATT,NOMINAL
          OUTPUT IMPEDANCE                50 OHM
          FREQ.RANGE                      215 TO 260MHZ
          FREQ.ACCURACY                   +/-0.005%
          CARRIER DEVIATION               +/-125KHZ
          TYPE MODULATION                 PHASE

620025 TRANSMITTER, KU BAND                              CA051   11235
620025
620025 PROVIDE KU BAND SIGNAL FOR EVALUATION OF PERFORMANCE CHARACTER-
620025 ISTICS OF TDRS/GROUND/SHUTTLE DATA LINK.
620025
620025    CARRIER FREQUENCY ............. 14.4 TO 15.35 GHZ
620025    STABILITY ..................... +/- 25 MHZ
620025    TRANSMITTER POWER ............. 100 WATTS
620025    EFFECTIVE RADIATED POWER ...... 33 DBW
620025    DATA RATE ..................... 1.0 MBS
620025                                    VIDEO
620025    DUTY CYCLE .................... CONTINUOUS
620025    SIGNAL BANDWIDTH .............. 500 MHZ
620025
     WATKINS-JOHNSON             #WJ-1049                       112

     COBER ELECTRONICS INC.      #915                           122
          FREQUENCY                       16.0-16.4GHZ
          POWER                           150 WATTS
          MODE                            PULSE
          PRF                             60 TO 4000
          PULSE WIDTH                     0.2 TO 1.2MICROSEC.

220041 LASER ASSEMBLY - CO2                              CA052   11111
220041
220041 PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE
220041 AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS
220041 APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH
220041 CONTROL, MODULATOR, AND COOLING SYSTEM.
220041
220041    LASER CAVITY
220041       WAVELENGTH ................. 10.6 MICRONS
220041       LASING MODE ................ FUNDAMENTAL (TEM..)
220041       OPTICAL OUTPUT POWER ....... 5 WATTS AVERAGE
220041       EFFICIENCY ................. 5 PERCENT
220041    MODULATOR
220041       TYPE ....................... DIGITAL
220041       DATA RATE .................. 200 MBPS
220041       EXTINCTION RATIO ........... 20 DB
220041    COOLING SYSTEM
220041       COOLING METHOD ............. CONDUCTIVE, NO LIQUIDS ALLOWED
220041       HEAD LOAD .................. 200 WATTS
220041
     SYLVANIA ELECTRONICS        #940             $10,000
          OUTPUT......................... 5 WATTS AT 10.6 MICRONS
          FREQUENCY STABILITY............ < 15 MHZ AFTER 1/2 HR WARM-
                                          UP, OVER SEVERAL HOURS
          AMPLITUDE STABILITY............< 5 %
          WEIGHT.........................27LBS (HEAD), 40LBS PWR SPLY

     HUGHES                                                     115
          LASER HEAD..................... 695 X 8 X 38 IN. 27 LBS

227400 LASER ASSEMBLY - ND:YAG                           CA053   11111
227400
227400 PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE
227400 AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS
227400 APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH
227400 CONTROL, MODULATOR, AND COOLING SYSTEM.
227400
227400    LASER CAVITY
227400       WAVELENGTH ................. 1.06 MICRONS
227400       LASING MODE ................ FUNDAMENTAL (TEM..)
227400       OPTICAL OUTPUT POWER ....... 1 WATT AVERAGE
227400       EFFICIENCY ................. 1 PERCENT
227400    MODULATOR
227400       TYPE ....................... DIGITAL
227400       DATA RATE .................. 1 GBPS
227400       EXTINCTION RATIO ........... 2000
227400    COOLING SYSTEM
227400       COOLING METHOD ............. CONDUCTIVE, NO LIQUIDS ALLOWED
227400       HEAD LOAD .................. 200 WATTS
227400
227400 LASER LINK, DOUBLED ND:YAG                        CA054   11111
227400
227400 PROVIDE SOURCE OF COHERENT OPTICAL ENERGY TO BE USED TO REFINE
227400 AND EXTEND KNOWLEDGE OF THE USE OF LASERS IN SPACE COMMUNICATIONS
227400 APPLICATIONS. CONTAINS OPTICAL TRANSMITTER INCLUDING BEAMWIDTH
227400 CONTROL, MODULATOR, DOUBLER, AND COOLING SYSTEM.
227400
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227400    LASER CAVITY
227400       WAVELENGTH ................... 0.53 MICRONS
227400       LASING MODE .................. FUNDAMENTAL (TEM..)
227400       OPTICAL OUTPUT POWER ......... 0.1 WATTS AVERAGE
227400       EFFICIENCY ................... 0.1 PERCENT
227400    MODULATOR
227400       TYPE ......................... DIGITAL
227400       DATA RATE .................... 1 GBPS
227400       EXTINCTION RATIO ............. 20 DB
227400    COOLING SYSTEM
227400       COOLING METHOD ............... CONDUCTIVE, NO LIQUIDS ALLOWED
227400       HEAD LOAD .................... 200 WATTS
227400
    HOLOBEAM                      #256              $13000         115
       WAVELENGTH ...................... .53 OR 1.06 MICRONS
       MODE ............................ MULTI OR TEM..
       CW POWER ........................ TO 50 WATTS

227400 LASER BEACON , ND:YAG                                CN055   111.1
227400
227400 SERVE AS A LIGHT SOURCE TO FACILITATE ACQUISITION AND/OR TRACKING
227400 FROM A DISTANT COMMUNICATION TERMINAL.
227400
227400    BEACON TYPE ..................... Q-SWITCHED DOUBLED, MULTIMODE
227400                                      CAVITY.
227400    WAVELENGTH ...................... 0.53 MICRONS (PREFERRED)
227400    REP RATE ........................ 5 PPS
227400    ENERGY/PULSE .................... 20 MJ AT 0.53 MICRONS
227400    PULSEWIDTH ...................... 20 MSEC
227400    PUMP METHOD ..................... FLASH PUMP
227400    CODING TECHNIQUE ................ PULSE POSITION MODULATION
227400    BEAMWIDTH ....................... VARIABLE 1 DEG TO 1 ARC MINUTE
227400    LIFETIME ........................ 10 MEG FLASHES OR GREATER
227400    POWER CONSUMPTION ............... 100 WATTS
227400
181000 FREQUENCY SYNTHESIZER AND DRIVER                     CN056   11111
181000
181000 RECEIVER FIRST LOCAL OSCILLATOR.
181000
181000    FREQUENCY ....................... DC TO 500 MHZ
181000    STABILITY ....................... +/- 5E-11 PER DEG C
181000    OUTPUT VOLTAGE .................. 1 V RMS +/- 1.5 DB
181000
    ROHDE AND SCHWARZ             #SMDW (103.9968.52)                111
       FREQUENCY RANGE ................ C - 500 MHZ
       OUTPUT LEVEL ................... 0.2 MICROVOLT TO 2 VOLT
       SPURIOUS SIGNAL SUPPRESSION .... > 86 DB

    HEWLETT PACKARD               #5100A/5110B      $13250         111
       FREQUENCY ...................... DC TO 50MHZ
       OUTPUT VOLTAGE ................. 1 V RMS +/- 1 DB 100 KHZ TO 50
                                        MHZ. 1 V RMS + 2 DB, - 4 DB 50
                                        HZ TO 100 KHZ INTO 50 OHM LOAD
       DIGITAL FREQUENCY SELECTION .... 0.01 HZ TO 10 MHZ PER STEP.

618100 NOISE FIGURE TEST SET                                CN057   11111
618100
618100 MEASURE SYSTEM NOISE FIGURE.
618100
618100    NOISE FIGURE RANGE .............. 10 TO 16 DB
618100    ACCURACY ........................ +/- 0.5 DB, 0 - 30 DB
618100    INPUT FREQUENCY ................. 100 TO 1000 MHZ
618100    BANDWIDTH ....................... 1 MHZ
618100
    GENERAL MICROWAVE             551               $1400          111
       FREQUENCY RANGE ................ 30, 45, 60, 70, 105, 120, 130,
                                        140, OR 200 MHZ. PLUG-IN UNITS
                                        EXTENDS RANGE TO 140GHZ.
       NOISE FIGURE RANGE ............. 0 TO 30 DB
       ACCURACY ....................... +/- 0.25 DB FOR 0-20 DB
                                        +/- 0.5 DB FOR 20-26 DB
                                        +/- 1.0 DB FOR 26-30 DB
       BANDWIDTH ...................... 1 MHZ

055050 SCOPE CAMERA                                         CN058   21111
055050
055050 OBTAIN FILM RECORD OF DATA AND DISPLAYS.
055050
055050    REDUCTION RATIO ................. 1:1, 1:0.7
055050    LENS ............................ F/1.5 TO F/16
055050    SHUTTER ......................... 8 TO 5 SECONDS
055050    FILM TYPE ....................... POLAROID
055050
    TEKTRONIX INC                 #C-27-P           $590           111
       SHUTTER ........................ MECHANICAL (ELECTRICAL OPTION)
       FILM BACK ...................... PACK-FILM (ROLL FILM AND 4X5
                                        GRAFLEX OPTIONAL)
       SHUTTER SPEED .................. 1 TO 1/50 SEC, BULB AND TIME
       LENS ........................... F/1.9, 0.85 MAGNIFICATION
    TEKTRONIX INC                 #C-55-P           $825           111
       SHUTTER ........................ ELECTRIC
       FILM BACK ...................... PACK-FILM (ROLL FILM AND 4X5
                                        GRAFLEX OPTIONAL)
       SHUTTER SPEED .................. 4 TO 1/60 SEC, BULB AND TIME
       LENS ........................... F/1.9, 0.85 MAGNIFICATION

    HEWLETT PACKARD               #157A             $675           111
       REDUCTION RATIO ................ 1:1 TO 1:0.7 (ADJUSTABLE)
       LENS ........................... 75 MM, F/1.9 HIGH TRANSMISSION
                                        LENS; APERATURE RANGES F/1.9 TO
                                        F/16
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    SHUTTER SPEEDS .................. 1/30, 1/15, 1/8, 1/4, 1/2, 1,
                                      2, 4, TIME, BULB
    CAMERA BACK ..................... POLAROID USING TYPE 107

  TEKTRONIX INC                 #C-12              $590
    LENS..............................75 MM
    STOP..............................F/1.9 TO F/16
    MAGNIFICATION.....................0.85
    LENS SPEED........................1 TO 1/100 SEC MECH
                                      4 TO 1/60 SEC ELEC
    FILM TYPE.........................POLAROID

  TEKTRONIX                     #C30               $525
    MAXIMUM RELATIVE APERTURE.........F/1.9
    MAGNIFICATION.....................0.7 TO 1.5
    RELATIVE SPEED....................1.0
    FIELD OF VIEW.....................3.15X3.93 IN (8X10 CM)
    FILM TYPE.........................POLAROID

  HEWLETT-PACKARD               #198               $420
    MAXIMUM RELATIVE APERATURE........F/3.5
    MAGNIFICATION.....................0.85
    SPEED.............................8 TO 1/60 SEC
    LENS..............................75 MM
    FILM TYPE.........................POLAROID

  HEWLETT-PACKARD               #195A              $1025
    MAXIMUM RELATIVE APERATURE........F/1.3
    MAGNIFICATION.....................0.9
    SPEED.............................8 TO 1/30 SEC
    LENS..............................80 MM
    FILM TYPE.........................POLAROID

179500 FREQUENCY COUNTER                                   CA059    11111
179500
179500 MEASURE FREQUENCY, PERIOD, MULTIPLE PERIOD AVERAGE, TIME INTERVAL
179500 AND RATIO OF FREQUENCY SOURCES.
179500
179500    BANDWIDTH ..................... 3 HZ TO 10 MHZ
179500    SENSITIVITY ................... 0.01 RMS
179500    TIME BASE ..................... INTERNATIONAL SECOND
179500
  JOHN FLUKE MFG CO INC         #1952A             $695         111
    FREQUENCY RANGE ................. DC TO 80 MHZ
    DISPLAY ......................... 7 DIGIT LED (8 OR 9 OPTIONAL)
    SENSITIVITY ..................... 50 MV RMS DC TO 50 MHZ INCREAS-
                                      ING TO 75 MV AT 80 MHZ
    PERIOD RANGE .................... DC TO 10 MHZ (DC COUPLED)
                                      5 HZ TO 10 MHZ (AC COUPLED)
    TIME INTERVAL RANGE ............. 0.1 MICROSEC TO 1E+6 SEC

  HEWLETT PACKARD               #5340A             $5600        111

  ROHDE AND SCHWARZ             #FET2(100.6C39.02/              111
                                      110.6125.02/
                                      100.6083.02/
                                      100.6051.02/
                                      100.6C68.02/
    FREQUENCY RANGE ................. 0 - 100 MHZ
    SENSITIVITY ..................... -5 TO +5 VOLTS
    PERIOD RANGE .................... 0.5 MICROSEC TO 100 SEC
    TIME INTERVAL RANGE ............. 0.2 MICROSEC TO 1E+6 SEC

608400 RF POWER METER                                      CA060    11111
608400
608400 MEASURE RF POWER OF VARIOUS RF SOURCES.
608400
608400    FREQUENCY RANGES .............. 126 TO 130 MHZ
608400                                    136 TO 144 MHZ
608400                                    2025 TO 2120 MHZ
608400                                    13.4 TO 14.2 GHZ
608400                                    14.4 TO 15.35 GHZ
608400    ACCURACY ...................... 0.02 DB/10 DB
608400
  ROHDE AND SCHWARZ             #NRS (100.2433.92/  $1945       111
                                  100.2440.XX)
    FREQUENCY RANGE ................. 0 TO 19 GHZ
    POWER RANGE ..................... 0.1 - 350 MW

  GENERAL MICROWAVE CORP        #471               $1675        111
    FREQUENCY RANGE ................. 10 MHZ TO 40 GHZ
    ACCURACY ........................ +/- 0.5% OF READING +/- 1 COUNT
    POWER RANGE ..................... 10 NANOWATTS TO 3 WATTS
    READOUT ......................... DIGITAL

  WEINCHEL                      #PB-10                          111
    RANGE ........................... 0.1 TO 45 MW
    ACCURACY ........................ +/-(0.1% + 1 MICRO-WATT)
    BIAS POWER SELF BALANCING ....... 1E+5 MIN (EFFECTIVE LOOP GAIN)
                                      1.0 MICROWATT/DIV (INDICATOR
                                      SENSITIVITY)
                                      0.2 MICROWATT (INDICATOR RESO-
                                      LUTION)

932000 AC/DC VOLTMETER                                     CM061    21111
932000
932000 MEASURE THE VOLTAGE LEVEL OF VARIOUS SIGNAL SOURCES.
932000
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532000     VOLTAGE RANGE ................... +/- 100 MV; 1, 10, 100, 1000 V
532000     FREQUENCY RANGE ................. 45 HZ TO 1 MHZ
532000     ACCURACY ........................ +/- 0.01 % OVERALL
532000
      ROHDE AND SCHWARZ              #URU (100.0060.02)   $1210          111
           FREQUENCY RANGE ................. DC, 10 HZ TO 1.5 GHZ
           VOLTAGE RANGE ................... 5 MV TO 1 KV (DC)
                                             0.1 TO 1000 V (AC)
           ACCURACY ........................ +/- 2% (DC), +/- 3% (AC)

      FLUKE                          #8200A                 $995         111
           VOLTAGE RANGE.................... 100MICROVOLTS TO 1200VOLTS DC
                           ................. 1 MV TO 1100V AC
           RESISTANCE....................... 10 MIL OHM TO 16 MEGOHMS
           READOUT.......................... NEON TUBE DISPLAY
                   ......................... PRINTER OUTPUT OPTION
           ACCURACY......................... +/- .001 % OF INPUT
           RESOLUTION....................... .01 PER CENT OF RANGE
           POWER............................ 115/230 V 50-440HZ  25W
           DIMENSIONS....................... 19.7X24.1X41.4CM
           WEIGHT........................... 6.75KG

      HEWLETT PACKARD                #3450B WITH OPTIONS  $4575          111
                                     001, 004
           DISPLAY ......................... 6 DIGITS
           DC VOLTAGE RANGE ................ +/- 100 MV, +/- 1, 10, 100 AND
                                             1000 V
           RANGE SELECTION ................. MANUAL OR AUTOMATIC
           FREQUENCY RANGE ................. 45 HZ TO 1 MHZ
           AC VOLTAGE RANGE ................ 1, 10, 100, 1000 V RMS

103500 A/D CONVERTER                                        CN062   21111
103500
103500 CONVERT INPUT SIGNAL FROM ANALOG TO DIGITAL FORMAT FOR I/O UNIT
103500
      ANALOG DEVICES INC.            #ADC-8S                $79          111
           RESOLUTION                        8 BITS
           ERROR                             +/-0.2%
           CONVERSION TIME                   1 MILLISEC.

      ANALOG DEVICES INC.            #ADC-12QZ              $305         111
           RESOLUTION                        12 BITS
           ERROR                             +/-0.0125%
           CONVERSION TIME                   25MICROSEC.

      ANALOG DEVICES INC             #ADC-16Q               $1350        111
           RESOLUTION                        16BITS
           ERROR                             +/-0.0015%
           CONVERSION TIME                   400MICROSEC.

      TENNELEC                       #TC500                 $6000
           CONVERSION TIME..................3 MICRO SEC
           CAPACITY......................... 2048 CHANNELS
           CONFIGURATION.................... COMPATIBLE WITH NIM

      TENNELEC                       #TC 520                $750         111
           CHANNELS......................... 8
           CHANNEL DWELL TIME............... 300NSEC
           CONFIGURATION.................... NIM COMPATIBLE

      ROHDE AND SCHWARZ              #UCM 210/1                          111
                                     (221.5403.02)
           ANALOG INPUT RANGE .............. +12 TO -12 VOLTS
           SAMPLING RATE ................... > 10000 MEAS/SEC (POSITIVE)
                                             > 17000 MEAS/SEC (NEGATIVE)
           DATA OUTPUT ..................... 3+1 DECADES (BCD CODE PARALLEL)
                                             0-1200 PULSES (SERIAL)

055055 CAMERA, CINE                                         CN063   11111
055055
055055 PROVIDE PHOTOGRAPHIC RECORD OF TELESCOPE FIELD-OF-VIEW.
055055
055055     FILM FORMAT ..................... 35 MM
055055     OPERATION ....................... REMOTE
055055     FRAME RATE ...................... 16 FPS
055055     FILM TYPE ....................... COLOR
055055     RESOLUTION ...................... 50 LINES/MM
055055     LENS ............................ 100 MM
055055     FIELD OF VIEW ................... 40 DEGREES
055055
      J A MAURER INC                 #317-E1                $4500        311
           MODES ........................... 8, 16, 32, 64 FPS ELECT CONT
           SHUTTER ......................... ROTARY
           SHUTTER SPEEDS .................. 1/62.5 TO 1/500 SEC
           FILM ............................ 16 MM MAGAZINE
           FILM CAPAACITY .................. 150 FT THIN BASE
           LENS ............................ 25 MM, F/1.4
           RESOLUTION ...................... 236 L/MM ON AXIS, 150 L/MM AVG

      J A MAURER INC                 #308              $15 - 20,000      511
           FILM ............................ 16 MM DOUBLE OR SINGLE PERFOR-
                                             ATED
           FORMAT .......................... 0.295 X 0.404 INCH
           FRAME RATE ...................... 1, 6, 12 AND 24 FR/SEC, TIME
           SHUTTER SPEED ................... TIME, 1/60, 1/125, 1/250, 1/500
                                             AND 1/1000 SEC
           FILM CAPACITY ................... 90 FT STD-BASE FILM, 145-165 FT
                                             THIN-BASE FILM
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       FLOWN ON APOLLO

603002 OPTICAL ANTENNA SERVO ELECTRONICS                   CN066   11114
603002
603002 SUPPORT ELECTRONICS FOR OPTICAL ANTENNA
603002
618010 SWEPTBAND RECEIVER AND DEMODULATOR                  CN067   41111
618010
618010 RECEIVE SIGNALS FROM TERRESTRIAL NOISE AND TERRESTRIAL INTERFER-
618010 ENCE SOURCES AS A FUNCTION OF TIME OF DAY AND SEASON OF YEAR.
618010
618010    FREQUENCY RANGE ............... 100 TO 1000 MHZ SWEEP MODE OR
618010                                    TUNABLE
618010    RECEIVER TYPE ................. SUPERHETERODYNE, LINEAR, SWEPT
618010                                    FREQUENCY, AGC
618010    SENSITIVITY ................... -120 DBM
618010    PRE-DETECTION BW .............. ADJUSTABLE
618010    DYNAMIC RANGE ................. 60 DB INSTANTANEOUS
618010                                    120 DB TOTAL
618010    SWEEP RATE .................... TWO RECEIVER BW PER MINUTE
618010    RECEIVER NOISE FACTOR ......... 4.0 DB
618010    BANDWIDTH ..................... 1 KHZ
618010
     SINGER                    #NM-37/57          $12,900          311
       A PROGRAMMABLE PRECISION METER FOR MEASUREMENT OF CONDUCTED
       OR RADIATIVE RF INTERFERENCE. MEETS MIL-STD-461/826.
       FREQUENCY BANDWIDTH............ 30MHZ TO 1GHZ
       DYNAMIC RANGE.................. 140DB (0.1MICROVOLT-1VOLT)
       PROGRAMMABLE FUNCTIONS......... BAND SELECTION, FREQUENCY
                                       TUNING; DETECTOR FUNCION (PEAK
                                       50MS, PEAK 300MS, PEAK 3SEC,
                                       QUASI-PEAK AND FIELD INTENSITY)
                                       ; BANDWIDTH SELECTION, CONTIN-
                                       UOUS IF GAIN; RF ATTENUATOR.

276000 ATTENUATOR CALIBRATOR                               CN068   41111
276000
276000 DYNAMIC RANGE ADJUSTMENT, REMOTE ELECTRICAL CONTROL, DIGITAL READ
276000 OUT OF VALUE, MANUAL OVER-RIDE.
276000
276000    IMPEDANCE ..................... 50 OHMS
276000    FREQUENCY ..................... DC TO 1.5 MHZ
276000    RANGE ......................... 0 TO 60 DB
276000
104360 SCAN PROGRAM GENERATOR                              CN069   31111
104360
104360 GENERATES DIGITAL CONTROL SIGNALS TO CONTROL RECEIVER SWEEP.
104360 SUPPLIES DIGITAL READOUT OF FREQUENCY AND LEVEL.
104360
104360    BANDS ......................... 24
104360    SCAN TIME ..................... 0.03 TO 300 SECONDS
104360    CAPABILITY .................... ANALOG DATA COLLECT & DISPLAY
104360
     SINGER                    #P-7               $5,000           311
       SELECTS ANY RECEIVER COMBINATION
        AND FOLLOWING RECEIVER FUNCTS.. BAND(24 BANDS); BAND SEGMENT;
                                       BANDWIDTH(NARROW, MEDIUM, WIDE)
                                       ; DETECTOR MODE (5 MODES); SCAN
                                       TIME (VARIABLE .03 TO 300 SEC).
       BANDS SCANNED.................. 1 TO 24 IN ANY COMBINATION
       OUTPUT DATA CHANNELS........... 3-AMPLITUDE,FREQUENCY AND LOG
                                       VIDEO

219700 SIGNAL FORMATTER                                    CN070   21111
219700
219700 PROVIDES DATA FORMATTING. ACCUMULATES PRE/POST AMBLE. CLOCKS
219700 START OF EACH TEST AND DATA ACQUISITION.
219700
219700    DATA FORMAT ................... 8, 16, 32, BITS/WORD
219700    DATA RATE ..................... 125000 WORDS PER SECOND
219700
     TEKTRONIX INC             #4002A                              111
       DISPLAY MEDIUM ............ 11 IN DIA CRT
       DISPLAY AREA .............. 8.3IN.HOR.X6.1IN.VERT.
       ALPHANUMERIC MODE:
         FORMAT .................. 39LINES OF 85 NORMAL CHARACT.
         CHARACTER SET ........... 96 UPPER & LOWER CASE
         CHARACTER SIZE .......... 70X5CMILS(CAN BE TWICE SIZE)
         CHARACTER GENERATION .... 7X9 DOT MATRIX
         CURSOR .................. PULSATING 7X9 MATRIX
       GRAPHIC MODES ............. LINEAR INTERPOLATE,INCREMENTAL
                                   PLOT,POINT PLOT,1024X1024 AD-
                                   DRESSABLE POINTS,1024X761 VIEW-
                                   ABLE POINTS
         GRAPHIC INPUT MODE ...... 1024(X),761(Y),JOYSTICK CONTROLLED,
                                   CROSSHAIR CURSOR
       ACCUMULATORS .............. 4
       CYCLE TIME ................ 300 NANOSEC
       CORE MEMORY ............... 32 K

409300 RF VARIABLE POWER SUPPLY                            CN071   21111
409300
409300 PROVIDES SOURCE OF VARIABLE POWER.
409300
409300    OUTPUT ........................ 100 V PEAK
409300    VOLTAGE GAIN .................. 20 X
409300    DISTORTION .................... 0.1 % THD
409300    FREQUENCY RANGE ............... DC TO 30 KHZ
409300
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       JOHN FLUKE MFG CO INC          #4270A                    $1895          111
            PROG CODING ...................... BCD (BINARY AVAILABLE)
            OUTPUT VOLTS ..................... 0 TO +/- 100 VOLTS DC/PEAK AC
            OUTPUT CURRENT ................... 0.5 AMPS
            FREQUENCY RANGE .................. DC TO 30 KHZ
            RESOLUTION ....................... 1 MV
            RESOLUTION ....................... 0.001%

407000 POWER CALIBRATION UNIT                                       CN072    21111
407000
407000 PROVIDES KNOWN INCREMENTALLY CONTROLLABLE POWER LEVEL FOR
407000 STANDARDIZATION.
407000
407000     OUTPUT ........................ -100 TO +100 V
407000     LOAD REGULATION ............... 1 MV + 0.01 %
407000     LINE REGULATION ............... 10 MV + 0.01 %
407000
       JOHN FLUKE MFG CO INC          #4270A                    $1895          111
            PROG CODING ...................... BCD (BINARY AVAILABLE)
            OUTPUT VOLTS ..................... 0 TO +/- 100 VOLTS DC/PEAK AC
            OUTPUT CURRENT ................... 0.5 AMPS
            FREQUENCY RANGE .................. DC TO 30 KHZ
            RESOLUTION ....................... 1 MV
            RESOLUTION ....................... 0.001%


       JOHN FLUKE MFG CO INC          #332B                     $2445          111
            OUTPUT VOLTAGE ................... 0 TO 1111.1110 VDC
            OUTPUT CURRENT ................... 50 MA
            REGULATION ....................... 0.0002%

620002 TRACKER ELECTRONICS - FINE                                   CN073    21114
620002
620002 PROVIDES ACCURATE TRACKING OF AN OPTICAL BEACON. PROVIDES CONTROL
620002 SIGNALS TO THE TELESCOPE GIMBALS AND VERNIER BEAM DEFLECTOR.
620002
620002     TYPE .......................... IMAGE DISSECTOR TRACKER
620002     FOV ........................... +/- 300 MICRORAD
620002     ACCURACY ...................... 0.5 MICRORAD
620002     SENSITIVITY ................... TO 1.06 MICRONS OR 10.6 MICRONS
620002
110300 BIT ERROR COUNTER                                            CN074    11111
110300
110300 COUNT ERROR PULSES OUTPUTED BY THE BIT ERROR DETECTOR TO DETER-
110300 MINE THE BIT ERROR RATE OF THE DIGITAL TRANSMISSION SYSTEM.
110300
       HEWLETT PACKARD                #5376A                    $1350          111

603003 SWITCH/DIPLEX/PREAMP UNIT                                    CN077    11134
603003
603003 FOR SWITCHING ANTENNAS FOR DIFFERENT ALTITUDES, USE [illegible] RFI
603003 CANCELLATION, FORMING OMNI PATTERN ETC
603003
219900 MODEM                                                        CN078    11114
219900
219900 MODULATE AND DEMODULATE VOICE OR DATA TRANSMISSIONS WITH OR WITH-
219900 OUT SPREAD SPECTRUM CAPABILITY. PROVIDES BASELINE COMMUNICATION
219900 SYSTEM, ANALOG OR DIGITAL VOICE, AND DIGITAL DATA.
219900
219900     DATA .......................... 75 BS TO 50 KBS (VARIABLE)
219900                                     MOVEABLE SS
219900     BANDWIDTH ..................... 2 MHZ
219900
219900 DEMODULATOR                                                  CN079    31111
219900
219900 DEMODULATE VOICE OR DATA TRANSMISSIONS WITH OR WITHOUT SPREAD
219900 SPECTRUM CAPABILITY. PROVIDES A NUMBER OF RECEIVERS CONNECTED TO
219900 DIFFERENT ANTENNAS.
219900
219900 MODEM, WIDEBAND                                              CN080    21235
219900
219900 MODULATE AND DEMODULATE WIDEBAND FM OR DIGITAL SIGNALS. WIDEBAND
219900 FM DETECTOR WITH THRESHOLD EXTENSION. DIGITAL DEMOD WITH BIT,
219900 SYNCH, AND ERROR CORRECTION CODING. MODULATOR PORTION HAS COMPLI-
219900 MENTARY CHARACTERISTICS.
219900
103500 D/A AND A/D CONVERTER                                        CN081    11111
103500
103500 PROVIDES FOR A/D AND D/A CONVERSION.
103500
103500     A/D CONVERTER
103500        SAMPLING RATES ............. 15 MEGASAMPLES/SEC
103500        DATA RATES ................. 105 MBS
103500     D/A CONVERTER
103500        BANDWIDTH .................. 6 MHZ
103500
       TENNELEC                       #TC500                    $6000          111
            CONVERSION TIME.................. 3MICRO SEC
            CAPACITY......................... 2048 CHANNELS
            CONFIGURATION.................... COMPATIBLE WITH NIM

       TENNELEC                       #TC 520                   $750           111
            CHANNELS......................... 8
            CHANNEL DWELL TIME............... 300NSEC
            CONFIGURATION.................... NIM COMPATIBLE

603004 CONTROL UNIT - ANTENNA SCAN                                  CN082    11114
603004
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603004 PROVIDES VARIABLE ANGULAR SWEEP PATTERNS (SPIRAL RECTANGULAR
603004 SCANS, ETC.) OF VARIABLE ANGULAR COVERAGE.
603004
103520 DATA BIT STREAM GENERATOR                          CN083    11111
103520
103520 PROVIDES TEST BIT STREAMS FOR TRANSMISSION.
103520
103520    DATA RATES ..................... 1 TO 105 MBS
103520
     RESEARCH INC                #812-4A              $2530          111
        ANALOG INPUT ..................... -10.240 TO +10.235 V
        INPUT IMPEDANCE .................. 100 MEG OHM
        INPUT OVERVOLTAGE PROTECTION ... +/- 100 V
        FULL SCALE ACCURACY ............. +/- 0.025 %
        RESOLUTION ....................... 12 BITS BINARY
        CONVERSION SPEED ................. 5 KHZ
        LOGIC LEVELS ..................... 5 +/- 1.5 V (LOGIC 1)
                                           0 + .4, - .0 V (LOGIC 0)

620003 COARSE TRACKER                                     CN084    11114
620003
620003 PROVIDES INITIAL GROUND BEACON ACQUISITION AND COARSE TRACKING.
620003
620003    DYNAMIC (SEARCH) FOV .......... 1 DEG BY 1 DEG
620003    ACCURACY (1 SIGMA) ............ +/- 200 MICRORAD
620003    TRACKING BANDWIDTH ............ 1 HZ
620003    SEARCH TIME ................... 10 SEC MAX
620003    SENSITIVITY ................... TO .53 MICRONS
620003    FALSE TARGET REJECTION ........ MUST REJECT MOON, PLANETS,
620003                                    STARS, AND SUNLIT CLOUDS.
620003
603002 LASER TRANSMITTER ELECTRONICS                      CN085    11235
603002
603002 DATA FORMATTING FOR TRANSMISSION VIA LASER CARRIER
603002
225700 OPTICAL COLLIMATOR                                 CN086    11111
225700
225700 PROVIDES FOR OPTICAL ALIGNMENT OF THE LASER AND TELESCOPE. ALIGN-
225700 MENT CHECKS TO BE BOTH CONTINUOUS AND PULSED.
225700
     TROPEL                      #280                 $2990          111
        SPECTRAL RANGE.................... .45 TO 1.10 MICRONS
        OPTICAL TRANSMISSION............. 92 PER CENT

     TROPEL                      #290                 $1350          225
        SPECTRAL RANGE.................... 10.6 MICRONS

     DAVIDSON                    #D600                $1582          112

407000 LASER POWER SUPPLY                                 CN087    21111
407000
407000 CONVERTS AND REGULATES RAW SPACECRAFT POWER IN A FASHION SUITABLE
407000 FOR PUMPING A LASER. PRIME LASER POWER CONDITIONER AND DISTRIBU-
407000 TION FOR ALL LASERS.
407000
407000    REGULATION ..................... +/- 0.1 %
407000    POWER .......................... 100 WATTS MAX
407000    TRANSIENT RECOVERY ............ 0.1 SECONDS
407000
225700 BEAM EXPANDER OPTICS                               CN088    21111
225700
225700 PROVIDES VARIABLE BEAM DIVERGENCE CONTROL FOR LASER TRANSMITTER
225700 AND THE OPTICAL BEACON TO FACILITATE ACQUISITION.
225700
225700    TYPE ........................... AFOCAL WITH VARIABLE ELEMENT
225700                                     SEPARATION.
225700    INPUT BEAM SIZE ................ 0.25 INCH DIA
225700    EXIT BEAM SIZE ................. 1 INCH DIA
225700    INPUT BEAM CHARACTERISTICS
225700       LASER TRANSMITTER .......... TEM WAVE, GAUSSIAN DIST
225700       OPTICAL BEACON ............. 3 MRAD DIVERGENCE, GAUSSIAN
225700                                     DIST
225700    OUTPUT BEAM DIVERGENCE
225700       CO2 LASER TRANSMITTER ...... DIFF LIMIT TO 200 ARC-SEC
225700       ND:YAG LASER TRANSMITTER .. DIFF LIMIT TO 50 ARC-SEC
225700       OPTICAL BEACON ............. 2 ARC-MIN TO 1 DEGREE
225700    ADJUSTMENT RESPONSE TIME ...... 0.5 SEC MAX
225700
225700 BEAM DEFLECTOR                                     CN089    41111
225700
225700 ONE TYPE PROVIDES A VERNIER POINTING CONTROL WITH FASTER RESPONSE
225700 AND GREATER PRECISION THAN THE MAIN OPTICS GIMBALS. THE OTHER
225700 TYPE PROVIDES A SMALL OFFSET POINTING CAPABILITY BETWEEN THE
225700 TRACKER AXIS AND THE TRANSMITTER AXIS.
225700
225700    DEFLECTION CAPABILITY ......... TWO AXIS
225700    DEFLECTION RANGE .............. +/- 200 MICRORAD
225700    PRECISION ...................... +/- 0.2 MICRORAD
225700    SPECTRAL RANGE ................. ACCOMODATE LASER TRANSMITTER,
225700                                     RECEIVER AND BEACON.
225700
409400 LASER POWER METER                                  CN090    11111
409400
409400 MEASURE OUTPUT LASER POWER.
409400
409400    WAVELENGTH ..................... 0.53, 1.06 AND 10.6 MICRONS
409400    ACCURACY........................ +/- 5 PERCENT
409400    RANGE .......................... 300 MW
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Space Division
Rockwell International

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405400
    HADRON                          #99                 $1050        111
        WAVELENGTH.......................... .3 TO 11 MICRONS
        ACCURACY............................ +/- 5 PER CENT
        TYPE................................ CONE
        MAX POWER........................... 5J
        SENSITIVITY......................... 450 MU V/J
        RISE TIME........................... 5 SEC

    OPTICS TECHNOLOGY               #615                $445         111
        MOUNT............................... BENCH
        SPECTRAL RANGE...................... 400 TO 1150NM
        DYNAMIC RANGE....................... 8 RANGES WITH FULL SCALE
                                             READINGS OF 0.2,1,3,10,30,100,
                                             300 AND 1000 MILLIWATTS
        ACCURACY............................ +/-5%

    YELLOW SPRINGS INSTRUMENT       #54                 $395         111
        RANGE............................... 0 TO 20 PPM
        OPERATING TEMPERATURE...............28 TO 113F (-2 TO 45C)
        BATTERY OPERATED

181000 CALIBRATION SIGNAL GENERATOR                          CA091   11111
181000
181000 CALIBRATES RECEIVER SENSITIVITY AND PHASE METER.
181000
181000    FREQUENCY RANGE ................ 1569.75 TO 1570.25 MHZ
181000    FREQUENCY ACCURACY ............. +/- 5 MHZ
181000    FREQUENCY STABILITY ............ 0.005 %/DEGREE C
181000    RF OUTPUT POWER ................ +10 DB TO -127 DB
181000
    RHODE AND SCHWARZ               #SMAI (100.4594.02)  $9675
        FREQUENCY RANGE .................... 0.5 - 1.8 GHZ                 111
        FREQUENCY ERROR .................... +/- 0.5%
        OUTPUT LEVEL ....................... +10 DBM TO -130 DBM

    LOGIMETRICS INC                 #PER SPEC           $7000        11-
        FREQUENCY .......................... 1500 TO 2000 MHZ
        RESOLUTION ......................... 1 HZ OR 1 KHZ (OPTIONAL)
        RF OUTPUT .......................... +10 DBM (LEVEL)
                                             +/- 1 DB (LEVELING)
        SPURIOUS OUTPUTS ................... 25 DB BELOW CARRIER (HARMONICS)
                                             80 DB BELOW CARRIER (NON-HAR)

    HEWLETT PACKARD                 #8614A              $2570        111
        FREQUENCY RANGE .................... 800 TO 2400 MHZ
        OUTPUT POWER ....................... +10 DBM TO -127 DBM INTO 50-OHM
        FREQUENCY ACCURACY ................. +/- 5 MHZ
        FREQUENCY STABILITY ................ 0.005 %/DEG C
                                             < 0.003 % FOR +/- 10 % LINE
                                             VOLTAGE VARIATION

006185 OPEN R.F. AMPLIFIER T.W.T                             CN092   51111
006185
618040 RECEIVER - NAVAGATION                                 CA096   11111
618040
618040 RECEIVE SIGNALS FROM DIRECT OPTICAL SENSING OF STARS TO INVESTI-
618040 GATE THE PRECISION WITH WHICH A SATELLITE CAN BE POINTED VERTIC-
618040 ALLY USING STARS AS THE SOLE INERTIAL REFERENCE.
618040
618040    CARRIER FREQUENCY .............. 400 MHZ
618040    SENSITIVITY .................... 2.0 MV FOR 10 DB S+N/N
618040    DATA RATE ...................... 2000 BPS
618040
    ROHDE AND SCHWARZ               #ESU (100.1195.02)   $7980        111
                                 ADD#PLUG IN-4          $6000        111
        FREQUENCY RANGE .................... 160 - 470 MHZ
        INPUT VOLTAGE ...................... 1 MICROVOLT TO 1 VOLT
        NOISE FIGURE ....................... <12 DB
        OUTPUT ............................. 2XIF, 2XAF, RECORDER

179500 SPECTRUM ANALYZER/OSCILLOSCOPE                        CA900   21111
179500
179500 SINGLE DESIGN FUNCTIONS AS POWER SPECTRAL DENSITY AND WAVEFORM
179500 DISPLAY FOR QUICKLOOK AND AS MODULATION MONITOR.
179500
179500    BANDWIDTH ...................... 18 GHZ
179500    SENSITIVITY .................... 2 MV/DIVISION
179500    CHANNELS........................ 2
179500    PHOTOGRAPHIC CAPABILITY ........ YES
179500
    TEKTRONIX INC                   #R7613/7A26 PLUG-IN $10150        111
                                     /7L13 PLUG-IN
        FREQUENCY RANGE .................... 10 KHZ TO 1.8 GHZ
        FREQUENCY SPAN ..................... 200 HZ/DIV TO 100 MHZ/DIV
        RESOLUTION ......................... 30 HZ TO 3 MHZ

    TEKTRONIX                       #R556               $4200        111
        BANDWIDTH .......................... DC TO > 50 MHZ
        RISETIME ........................... < 7 NSEC
        TYPE ............................... DUAL-BEAM


    TEKTRONIX INC                   #R491               $4995        112
        FREQUENCY RANGE .................... 10 MHZ TO 40 GHZ
        CALIBRATED DISPERSION .............. 1 KHZ/DIV TO 10 MHZ/DIV
        RESOLUTION BANDWIDTH ............... 1 KHZ TO 100 KHZ
        INCIDENTAL FM ...................... <300 HZ AT FUNDAMENTAL
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    TEKTRONIX INC                  #1401A-4          $3725        111
        FREQUENCY RANGE .................. 1 MHZ TO 900 MHZ
        INTERMODULATION DISTORTION ...... < 60 DB FULL SCREEN

102700 COMPUTER, GENERAL PURPOSE                            CN901   21111
102700
102700 COMPUTER CAPABILITY TO COMMAND EXPERIMENTS ON AND OFF, PROGRAM
102700 EXECUTION OF EXPERIMENT PROCEDURAL STEPS, COMPUTE GIMBAL
102700 ANGLES FOR TELESCOPE AND ANTENNA POINTING, AND COMPUTATION OF
102700 POINT-AHEAD ANGLES.
102700
    DATA GENERAL CORP              #NOVA 800                      111
        WORD LENGTH ...................... 16 BIT
        CYCLE TIME ....................... 800 NANOSEC.
        CORE MEMORY ...................... 32K MAX

    DATA GENERAL CORP              #SUPERNOVA SC                  111
        WORD LENGTH ...................... 16 BIT

    DATA GENERAL CORP              #NOVA 1200                     111
        WORD LENGTH ...................... 16 BIT
        CYCLE TIME ....................... 1200 NANOSEC.
        CORE MEMORY ...................... 32K MAX.

    VARIAN DATA MACHINES           #520/I                         111
        MEMORY CYCLE TIME ................ 1.5MICROSEC.
        MEMORY ........................... EXPANDABLE,4096BYTES(8BITS)TO
                                           32,768BYTES
        REGISTERS ........................ 12
        OPERAND PRECISION ................ UP TO 32 BITS

    VARIAN DATA MACHINES           #R-620/I                       111
        BASIC COMMANDS ................... OVER 100
        ADDRESSING MODES ................. 6
        MAX.WORDS ........................ 32,768
        WORD LENGTH ...................... 16 OR 18 BIT
        REGISTERS ........................ 9
        NOTE:                              HAS FULL RANGE INTERFACE
                                           HARDWARE

    CLARY DATACOMP SYSTEMS INC     #404                           111
        SIMULTANEOUS TERMINALS ......... 16
        INPUT ............................ TELETYPEWRITER KEYBOARD
        ACCUMULATOR ...................... 64 BIT
        REGISTERS ........................ 16 BIT INDEX (2 EACH)
        WORD LENGTH ...................... 16, 32, 48, 64 BITS
        MEMORY CAPACITY .................. 1024 16 BIT WORDS, 4096 16 BIT
                                           WORDS,OR ADDITIONAL 4096 16 BIT
                                           WORDS. TOTAL 65538 WORDS

    GENERAL AUTOMATION INC.        #18-30                         111
        FUNCTION ......................... SUPERVISE SMALLER COMPUTERS
        MEMORY............................ 8K CORE
        CYCLE TIME ....................... 1.2 MICROSEC.

    GENERAL AUTOMATION INC.        #SPC-16                        111
        MEMORY ........................... 16K
        WORD LENGTH ...................... 16 BITS
        READ/WRITE CYCLE MEMORY TIME ... 800 TO 1440 NANOSEC.
        READ ONLY MEMORY ................. 400 TO 720 NANOSEC.
        INPUT/OUTPUT TIME ................ 1.6 TO 2.8 MICROSEC.
        DMA TRANSFER RATE ................ 0.694E+06 TO 2.5E+06

    GENERAL AUTOMATION INC.        #SPC-12                        111
        MEMORY ........................... 4K TO 16K
        WORD LENGTH ...................... 8 BITS
        CYCLE TIME ....................... 2.16 MICROSEC
        STORED PROGRAM EXECUTION RATE .. 0.23E+06/SEC
        I/O TRANSFER RATE ................ 0.46E+06/SEC
        REGISTERS ........................ 6 12 BIT REGISTERS
        ACCUMULATORS ..................... 4 12 BIT

    DIGITAL EQUIPMENT CORP         #PDP-8/E          $22000       111
        MEMORY ........................... 4096(CORE)EXPANDABLE TO
                                           32,768 WORDS
        WORD ............................. 12 BIT
        CYCLE TIME ....................... 1.5 MICROSEC.
        ADDRESS REFERENCE ................ 8,16,24,OR 32 BIT LEVEL
        NOTE:                              HAS FULL RANGE INTERFACE
                                           HARDWARE

490300 TIMER, PRECISION CLOCK                               CN902   11111
490300
490300 PROVIDES PRECISE TIME REFERENCE. MEASURE TIME AT WHICH PHASE MEAS
490300 OCCURS.
490300
490300     DISPLAY ....................... 24 BIT DIGITAL CLOCK WITH 1 HR.
490300                                         TIME PERIOD
490300     DISPLAY TYPE .................. DIGITAL
490300     ACCURACY ...................... 1E-06
490300
    TENNELEC                       #TC545            $550         111
        COUNT RATE........................ 20MHZ
        TIMEBASE.......................... 0.1 OR 0.01SEC
        ACCURACY.......................... SAME AS LINE FREQUENCY
        CONFIGURATION..................... NIM COMPATIBLE
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ROHDE AND SCHWARZ              #CAD (100.6597.91)   $5400          111
     DISPLAY ......................... 6 DIGITS: HR, MIN, SEC
     OUTPUT .......................... 1-OUT-OF-N AND/OR BCD CODE
     PROGRAMMER.......................TIME PROGRAMS(COUNT
                                       DOWN) AND TIME SIGNALS

DATATRON                       #3350-506            $1170          111
     INPUT FREQUENCY.................. 60HZ
     OUTPUTS.......................... VISUAL,BCD
     DISPLAY.......................... HRS.MIN.SEC

104160 TELEPRINTER                                       CN903   11111
104160
104160 PROVIDES CAPABILITY TO SEND OR RECEIVE TELETYPE MESSAGES.
104160
104160     CHARACTER RATE ................ 30 CHARACTERS/SEC (150 BPS)
104160     CONSISTS OF ................... SOLID STATE KEYBOARD
104160                                     SOLID STATE THERMAL PRINTER
104160                                     EXPANDABLE MESSAGE MEMORY
104160
    VARIAN DATA MACHINES       #ASR 33 & ASR 35                    111
     SPEED ........................... 10 CHARACTERS/SEC.
     PAPER ........................... CONTINUOUS ROLL 8.5 IN WIDE
     TYPING LINE ..................... 85 CHARACTERS

101600 PHASE METER, DIGITAL                              CN904   11111
101600
101600 MEASURES RELATIVE PHASE ANGLES OF RECEIVED SIGNALS FOR INTERFER-
101600 OMETER NAVIGATION/SURVEILLANCE EXPERIMENT.
101600
101600     OUTPUT ........................ GENERATES 13 BIT PHASE MEAS
101600                                     BASED ON TWO 60 MHZ SINUSOIDS
101600                                     AT 10 DBM.
101600     FREQUENCY RANGE ............... 400 MHZ
101600     RESOLUTION .................... 25 KHZ
101600     ACCURACY ...................... +/- 2.5 KHZ
101600
    ROHDE AND SCHWARZ          #ZSK (100.1550.02)  $10500          111
     WRITING SPEED ................... 1.50 M/SEC
     DEFLECTION FACTOR ............... 10 MICROVOLT/CM TO 10 V/CM
     WRITING METHOD .................. ELECTRIC PEN

    HEWLETT PACKARD            #7035B               $985           111
     INPUT RANGE ..................... 1, 10, 100 MV/IN; 1 AND 10 V/IN
     WRITING METHOD .................. ELECTRIC PEN
     ACCURACY ........................ +/- 0.2 % FS
     LINEARITY ....................... +/- 0.1 % FS

424000 RECORDER, DIGITAL                                 CN905   11111
424000
424000 ACCURATE RECORDING OF RAW DIGITAL DATA
424000
424000     SIGNAL TYPE ................... 0 TO 5 VDC DIGITAL
424000     CHANNELS ...................... 9
424000     TAPE SPEED .................... VARIABLE
424000     DATA RATE ..................... 1.5E+06BPS
424000
    AMPEX CORPORATION          #AR-200                             121
     BANDWIDTH ....................... 100 HZ TO 3125 HZ THROUGH
                                       300 HZ TO 250 KHZ
     TAPE WIDTH ...................... 0.5 INCH
     TAPE SPEED ...................... 1.875 TO 60 IPS
     RECORDING TIME .................. 8 MINUTES TO 4 HRS AND 16 MINS
     FORMAT .......................... DIGITAL
     TRACKS .......................... 8 DIGITAL, 7 ANALOG

    SANGAMO ELECTRIC           #SABER III           $26,500        111
     TRACKS .......................... 14
     TAPE WIDTH ...................... 1 INCH
     TAPE SPEEDS...................... 8 SELECTABLE SPEEDS FROM 15/16
                                       TO 120 IPS
     FREQUENCY RESPONSE .............. 400 HZ TO 2.0 MHZ
     RECORDING RATE .................. 400 KBPS AT 120 IPS SERIAL MODE
     WEIGHT .......................... 100 POUNDS
    DIGI-DATA CORPORATION      #1600                $2650          111
     TAPE SPEED ...................... 25, 18.75, 12.5 IPS
     TRACKS .......................... 7 OR 9 TRACK
     DATA DENSITY .................... 1600 CPI PHASE ENCODED
                                       200, 556, 800 CPI NRZI
     TAPE ............................ 0.5 INCH, 1.5 MIL, 1200 FEET

    DIGI-DATA CORPORATION      #1700/PDP-11/7-9     $5250          111
                                TRACK NRZI
     TAPE SPEED ...................... 45, 37.5, 25, 18.75, 12.5 IPS
     TAPE ............................ 0.5 INCH, 1.5 MIL, IBM/ANSI
                                       COMPATIBLE, 10.5 INCH REEL
     TRACKS .......................... 7 OR 9
     DATA DENSITY .................... PHASE ENCODED
                                       COMPATIBLE

    HEWLETT PACKARD            #7970B/C             $ 4600         111
     TAPE FORMAT ..................... 800, 556, OR 200 CPI NRZI AND
                                       1600 CPI PHASE-ENCODED
     CHANNELS ........................ 7 OR 9
     TAPE SPEED ...................... 10 TO 45 IPS
     TAPE ............................ 0.5 INCH, 1.5 MILS, IBM/ANSI
                                       COMPATIBLE
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BORG WARNER                     #PERT                                   121
     TRACKS ......................... 30
     TAPE SPEED ..................... UP TO 1000 IPS
     TAPE WIDTH ..................... 1/2 INCH
     TAPE LENGTH .................... 2400 FEET
     PACKING DENSITY ................ 15 KB/I/T
     SIGNAL/NOISE ................... 24 DB
     DATA CAPACITY .................. 1.3E+9
     BANDWIDTH ...................... 6-15 MB/SEC/T

LEACH                           #MTR 7000                               311
     TRACKS ......................... 12
     TAPE SPEED ..................... 120 IPS
     TAPE WIDTH ..................... 1 INCH
     TAPE LENGTH..................... 9200 FEET
     PACKING DENSITY................. 16.7 KB/I/T
     SIGNAL/NOISE ................... 22 DB
     DATA CAPACITY .................. 2.2E+10
     BANDWIDTH ...................... 2 MB/SEC/T

HEWLETT PACKARD                 #3955D              $10200              111
     BANDWIDTH ...................... 300 KHZ
     CHANNELS ....................... 7
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                 #3955C              $14700              111
     BANDWIDTH ...................... 300 KHZ
     CHANNELS ....................... 14
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                 #3950A-011          $23900              111
     BANDWIDTH ...................... 500 HZ TO 2 MHZ
     CHANNELS ....................... 14
     RECORDING FORMAT ............... DIRECT OR FM

HEWLETT PACKARD                 #3960A/13065A/13063A $4796              111
     CONFIGURATION .................. RACK MOUNTED
     TAPE SPEED ..................... 15, 3 AND 3/4, 15/16 IPS
     CHANNELS ....................... 4
     RECORDING FORMAT ............... FM
     PASSBAND ....................... 5 KHZ
     S/N RATIO....................... 48 DB
     TRACKS ......................... 30

HONEYWELL                       #5600               $9730
     PORTABLE TAPE RECORDER
     CHANNELS........................ 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 60IPS
     MAXIMUM BANDWIDTH(DIRECT)....... 300KAZ
     PACKING DENSITY................. UP TO 600PBI
     WEIGHT.......................... 70LBS (32KG)
     INPUT VOLTAGE                    28VDC

HONEYWELL                       #96                 $17420
     CHANNELS........................ 7
     SELECTABLE TAPE SPEED RANGE..... 15/16 TO 240IPS
     REEL SIZE....................... 16IN
     MAXIMUM BANDWIDTH(DIRECT)....... 2M HZ
     TAPE WIDTH...................... 1/2 IN

AMPEX CORP                      #AR 700             $29,180             511
     TRACKS ......................... 14
     TAPE SPEED ..................... 60 IPS
     TAPE WIDTH ..................... 1 INCH
     RECORD MODE..................... DIRECT
     PACKING DENSITY ................ 20 KB/I/T
     SIGNAL/NOISE ................... 20 DB
     DATA CAPACITY .................. 8E+10 BITS
     BANDWIDTH ...................... 1 MB/SEC/T

AMPEX CORP                      #AR 1700            $28,000             112
     TRACKS ......................... 14
     TAPE SPEED ..................... 120 IPS
     TAPE WIDTH ..................... 1 INCH
     RECORDING MODE.................. DIRECT
     PACKING DENSITY ................ 20 KB/I/T
     SIGNAL/NOISE ................... 20 DB
     DATA CAPACITY .................. 6.2E+10
     BANDWIDTH ...................... 2 MB/SEC/T

530700 POWER DIVIDER, WIDEBAND                          CN906    41111
530700
530700 DIVIDES ANTENNA POWER OUTPUT.
530700
530700     INPUT PORTS .................. ONE 50 OHM PORT
530700     OUTPUT PORTS ................. THREE 50 OHM PORTS
530700
    MERRIMAC                    #PDM 3C                                 111
     FREQUENCY RANGE ................ 2-32 MHZ, 10-100 MHZ, 100-400
                                      MHZ
     COUPLING ....................... - 4.8 DB
     ISOLATION ...................... 30 DB, 30 DB, 25 DB
     VSWR ........................... 1.3:1
     POWER .......................... 5 WATTS
     CONNECTORS (4) ................. SMA
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430000 X-Y PLOTTER                                              CA907   11111
430000
430000 PROVIDES REAL-TIME ACCURATE REPRODUCTION OF SPECTRAL DATA SOURCES
430000 PLOTTED ON CARTESIAN COORDINATES.
430000
430000    CHANNELS ........................ 4 PLUG INS
430000    ACCELERATION .................... 1500 IN/S/S (3800 CM/S/S)
430000    SENSITIVITY ..................... 0.5MV/IN (0.25 MV/CM)
430000
101340 KEYBOARD, COMPUTER                                       CA909   11111
101340
101340 PROVIDES FOR CREWMAN TO COMMUNICATE WITH ONBOARD COMPUTER FOR
101340 EXPERIMENT CONTROL AND DATA ANALYSIS.
101340
101340    KEYBOARD ........................ TYPEWRITER TYPE
101340
   RESEARCH INC                  #DPS-912            $21,700          111
      COMPLETE DATA DISPLAY SYSTEM MADE UP OF CRT ALPHANUMERIC DISPLAY
      DEC-PDP8-F MINI-COMPUTER, #3301 OPERATIONS CONTROL CONSOLE,
      PRINTER/CARD READER, #812-4A ANAPLEXER AND #812-13 UNIDRIVER
      CHANNELS ........................ 32
      MEMORY SIZE ..................... 8K WORDS

   RESEARCH INC                  #812-3301           $1555            111
      SCREEN FORMAT ................... 12 LINES X 72 OR 80 CHARACTERS,
                                        24 LINES X 40 CHARACTERS
      CHARACTER FORMAT ................ 5 X 7 DOT MATRIX
      TRANSFER RATE ................... 110 TO 2400 BAUD, 10 OR 11 BIT
                                        CHARACTERS
      MODES ........................... HALF OR FULL DUPLEX-SWITCHABLE
                                        LOCAL OR REMOTE

   HEWLETT PACKARD               #2600A              $3590            111

   TEKTRONIX                     #4002A/021-00XX-00  $5550            111
      DISPLAY MEDIUM .................. 11 INCH DIRECT-VIEW, BISTABLE
                                        STORAGE CRT WITH REFRESHED
                                        SCRATCH PAD AREA
      DISPLAY AREA .................... 8.3 INCHES HORIZONTAL X 6.1
                                        INCHES VERTICAL
      ALPHANUMERIC MODE
         FORMAT ....................... 39 LINES OF 85 NORMAL OR ITALIC
                                        CHARACTERS IN MAIN AREA, ONE
                                        LINE OF 84 CHARACTERS IN
                                        SCRATCH PAD AREA
         CHARACTER SET ................ 96 UPPER AND LOWER CASE PRINT-
                                        ING CHARACTERS (ASCII CODE)
         CHARACTER SIZE ............... 70X90 MILS (CAN BE DOUBLE SIZE)
         CHARACTER GENERATION ......... 7X9 DOT MATRIX
         CURSOR ....................... PULSATING 7X9 MATRIX
      GRAPHIC MODES ................... LINEAR INTERPOLATE, INCREMENTAL
                                        PLOT, POINT PLOT, 1024X1024
                                        ADDRESSABLE POINTS, 1024X761
                                        VIEWABLE POINTS
      GRAPHIC INPUT MODE .............. 1024 (X), 761 (Y) POINTS. JOY-
                                        STICK CONTROLLED, CROSS-HAIR
                                        CURSOR

480000 CAMERA, TELEVISION                                       CA909   11131
480000
480000 PROVIDES ASTRONAUT WITH VIEW OF EARTH SCENE.
480000
480000    VIEW ANGLE ...................... 20 DEGREES
480000    RESOLUTION ...................... 625 LINES
480000    SPECTRAL BANDWIDTH .............. 4 MHZ
480000    SWEEP RATE ...................... 15 FRAMES PER SECOND
480000
   RCA ELECTRONICS COMPONENTS    #8521               $520             111
      TYPE ............................ VIDICON-SULFIDE TYPE
      PHOTOCONDUCTER .................. II
      IMAGE DIAGONAL .................. 25MM,1IN.
      FOCUS ........................... MANUAL
      LIMITING RESOLUTION ............. 1500 LINES

   COHU INC. ELECTRONICS DIV.    #1220               $8430            111
      IMAGE CONVERTER ................. 4846P VIDICON - COLOR
      RESOLUTION-HORIZONTAL LIMIT ..... 300 LINES MIN.
      GEOMETRIC DISTORTION ............ < 2 % OF PIC HEIGHT
      LENS MOUNT ...................... 16 MM - C-MOUNT

   COHU INC. ELECTRONICS DIV.    #2000               $3000            311
      LENS-BUILTIN .................... 4:1 (20-80 MM) F/2.5 ZOOM
      LENS ATTACHMENT ................. 4:1 (12.5-80 MM)
      LENS INTERCHANGEABLE ............ 10:1 (15-150 MM) F/2.8 ZOOM
                       ................ 16 MM C-MOUNT FFL
      10 MHZ BANDWIDTH (MOD 2006) .... 525 OR 729 LINE (VIDICON 7263A)
      20 MHZ BANDWIDTH (MOD 2004) .... 873 OR 945 LINE (VIDICON 8573)
      MIL SPECIFICATIONS .............. MIL-E-5272C, MIL-STD-810

   COHU INC. ELECTRONICS DIVISION#4500               $2225            311
      LENS ............................ 4:1 ZOOM
           ............................ 10:1ZOOM
      VERTICLE SWEEP RATE ............. 60FIELDS PER SEC
      HORIZONTAL SWEEP RATE ........... 525 LINES PER FRAME
      IMAGE TUBE TYPE ................. 8541A STD
      LENS MOUNT                        16 MM C-MOUNT
      MIL SPECIFICATIONS .............. MIL-E-5400P, MIL-E-5300P
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424200 RECORDER, VIDEO                                         CN910   11111
424200
424200 PROVIDES FOR RECORDING VIDEO DATA.
424200
424200    CHANNELS ...................... 2
424200    BANDWIDTH ..................... 4 MHZ MINIMUM
424200    DURATION ...................... 1.5 HRS MINIMUN
424200
    SANGAMO ELECTRIC CO            #7C-2                               121
       TAPE WIDTH ..................... 1INCH
       TAPE SPEED ..................... 120 IN./SEC.
       FREQ.RESPONSE(DIRECT) .......... 400HZ TO 2 MHZ
       SIGNAL/NOISE ................... 20DB
       CHANNFLS ....................... 14
       FORMAT ......................... FM

610080 RECEIVER, PHASE-LOCK                                    CN911   11111
610080
610080 PROVIDES FOR TRACKING SIGNAL PHASE.
610080
610080    FREQUFNCY SPECTRUM ........... 1570 MHZ TUNABLE
610080    SENSITIVITY .................. 15 KHZ
610080
104100 DISPLAY, CRT                                            CN912   11111
104100
104100 DISPLAY REAL-TIME OR VIDEO TAPE DATA.
104100
104100    RESOLUTION ................... 625 LINES
104100    FRAME RATE ................... 15 FPS
104100
    RESEARCH INC                   #3300              $1580
       FORMAT..........................24 LINESX72 OR 80 CHARACTERS
           ............................24 LINESX40 CHARACTERS
           ......... ................. 12 LINESX72 OR 80 CHARACTERS
       REFRESH RATE....................60 HZ
       TRANSFER RATE...................110 TO 2400 BAUD
       CHARACTER FORM..................5X7 DOT MATRIX
       DIMENSIONS......................19-1/2WX13-1/2HX23-1/2D INCH
       WEIGHT..........................39LB (17.7KG)
    BUNKER-RAMO CORP               #2217-12CRT        $950
       CHARACTER CAPACITY (MAX) ........ 960
       CHARACTERS/LINE (MAX) ........... 80
       LINES/DISPLAY (MAX) ............. 24
       CHARACTERS REPERTOIRE ........... 62 OR 92
       VIEWING AREA .................... 8.75 X 6.25
       REFRESH AREA .................... 54 FRAMES/SEC
       CHARACTER GENERATING METHOD ... 5X7 DOT MATRIX

    TEXTRONIX INC                  #4002A/021-0033-00/ $10975          111
                                    021-00XX-00/4901/
                                    4951
       ALPHANUMERIC FORMAT ............. 39 LINES-85 NORMAL/ITALIC CHAR,
                                         1 LINE- 84 CHAR IN SCRATCH AREA
       CHARACTER SET ................... 96 UPPER/LOWER CHAR (ASCII)
       CHARACTER SIZE .................. 70 X 90 MILS
       CHARACTER GENERATION ............ 7 X 9 DOT MATRIX
       CURSOR .......................... PULSATING 7 X 9 MATRIX
       GRAPHIC INPUT MODE .............. 1024(X) X 1024(Y) ADDRESSABLE.
                                         1024(X) X 761(Y) VIEWABLE PTS:
                                         JOYSTICK CONTROLLED, CROSS-HAIR
                                         CURSOR.

429500 VISICORDER                                              CN914   11111
429500
429500 REAL-TIME RAW DATA RECORDING.
429500
429500    BANDWIDTH ...................... DC TO 5000 HZ
429500    CHANNELS ....................... 18
429500    RECORDING FORMAT ............... CRT HARD COPY
429500
    HONEYWELL                      #1856               $
       RESOLUTION ...................... 200 ELEMENTS/INCH (1000/SWEEP)
       RECORDING RATE .................. 8E+06 BITS/SEC
       CRT ............................. FIBER OPTICS
       SPOT SIZE ....................... 0.005 INCH
       SWEEP SPEED ..................... 20,000 LINES/SEC

    HONEYWELL                      #1856               $
       RESOLUTION ...................... 200 ELEMENTS/INCH (1000/SWEEP)
       RECORDING RATE .................. 8E+06 BITS/SEC
       CRT ............................. FIBER OPTICS
       SPOT SIZE ....................... 0.005 INCH
       SWEEP SPEED ..................... 20,000 LINES/SEC
```

Space Division
Rockwell International

APPENDIX D

SPACELAB/EXPERIMENT EQUIPMENT INTERFACE REQUIREMENTS SPECIFICATION (SEEIR)

PREPARED BY *J J Hendricks* APPROVALS *R.P. Ayres*	CODE IDENT. NO.: 03953 SPACE DIVISION ROCKWELL INTERNATIONAL CORPORATION **SPECIFICATION**	NUMBER TYPE REQUIREMENTS DATE 4/25/74 SUPERSEDES SPEC. DATED: 2/15/74 REV. LTR. A PAGE 1 of 19

TITLE

SPACELAB/Experiment Equipment Interface Requirements

THIS DOCUMENT IS INTENDED AS A WORKING TOOL FOR THE STUDY ENTITLED ANALYSIS OF COMMERCIAL EQUIPMENT AND INSTRUMENTATION FOR SPACELAB PAYLOADS. IT IS NOT A CONTRACTUAL SPECIFICATION.

1. SCOPE

1.1 Scope. This document delineates the requirements for experiment equipments within pressurized areas of the Spacelab. Requirements include those that are mandatory for preservation of Spacelab-Shuttle safety margins and those necessary to achieve intended operation of equipments. Meeting the requirements herein does not, however, assure the ability to operate within Spacelab in an arbitrary fashion since combined equipment support demands could exceed total Spacelab capability. Integrated operation must therefore be coordinated with Spacelab operations management for specific missions in order to establish mutual operating timelines and allocation of Spacelab resources.

2. APPLICABLE DOCUMENTS

2.1 Applicability. The following documents were used in the derivation of the requirements and are referenced herein by title or by number in the text margins as appropriate. Interpretations were made where conflicts in documents existed or data were unavailable.

DOCUMENTS

(1)	ERNO Spacelab	Preliminary Design Requirements Specifications, December 1973; Final Briefing, February 1974
(2)	MBB Spacelab	Preliminary Design Requirements Specifications, December 1973
(3)	SL-E-0001	Electromagnetic Compatibility Requirements, Systems for the Space Shuttle Program, June 4, 1973
(4)	SL-E-0002	EMI Interference Characteristics, Requirements for Equipment for the Space Shuttle Program, June 4, 1973
(5)	SD 72-SH-0172	Space Shuttle Orbiter Materials Control and Verification Plan, November 1972
(6)	NHB 8060.1	Flammability, Odor and Off-Gassing, Requirements for Materials in Environments which Support Combustion, November 1971
(7)	U719-10-206	Material Code Directory by Material Description - Nonmetals, December 15, 1973 and subsequent issues
(8)	U719-10-207	Material Code Directory by Material Description - Metals, December 15, 1973 and subsequent issues
(9)	U719-10-208	Material Selection Rating and Criteria Report - Metals, December 15, 1973 and subsequent issues
(10)	U719-10-209	Material Selection Rating and Criteria Report - Nonmetals, December 15, 1973 and subsequent issues
(11)	Federal Standard 209A	Clean Room and Work Station Requirements for Controlled Environments, CSA, August 10, 1966

(12) MSC00720 Solar-Powered Space Station Preliminary Design

(13) No Number Draft, Interim Spacelab Reference Document, February 1974

(14) ESRO RFP AO/600 Request for Proposal for the Design and Development Contract (Phase C/D), Appendix 11, System Requirements, March 1, 1974

(15) JSC 07700 Volume XIV Space Shuttle System Payload Accommodations, Revision A, July 1973

3. REQUIREMENTS

3.1 General.

3.1.1 Spacelab Design Characteristics. The following Spacelab characteristics establish the basis for the experiment equipment requirements specified in paragraph 3.2, and establish the maximum total Spacelab support available for combined experiment and Spacelab subsystems hardware.

3.1.1.1 Physical Perspective. Figure 1 provides the general Spacelab configuration and defines the axes coordinate system used to interpret applicable specifications herein. The Spacelab consists of pressurized module and unpressurized pallet elements flown together or independently, depending upon the mission. Size of the Spacelab elements may vary, depending upon the nature of the mission. The pressurized module consists of a support section containing Spacelab subsystems as well as accommodations for experiment equipment, plus an experiment section that can be configured in various lengths to accommodate additional experiment equipments. This specification does not cover pallet-mounted equipment requirements. Pallet equipment, however, shares available power and data handling support with pressurized module equipments. (1)

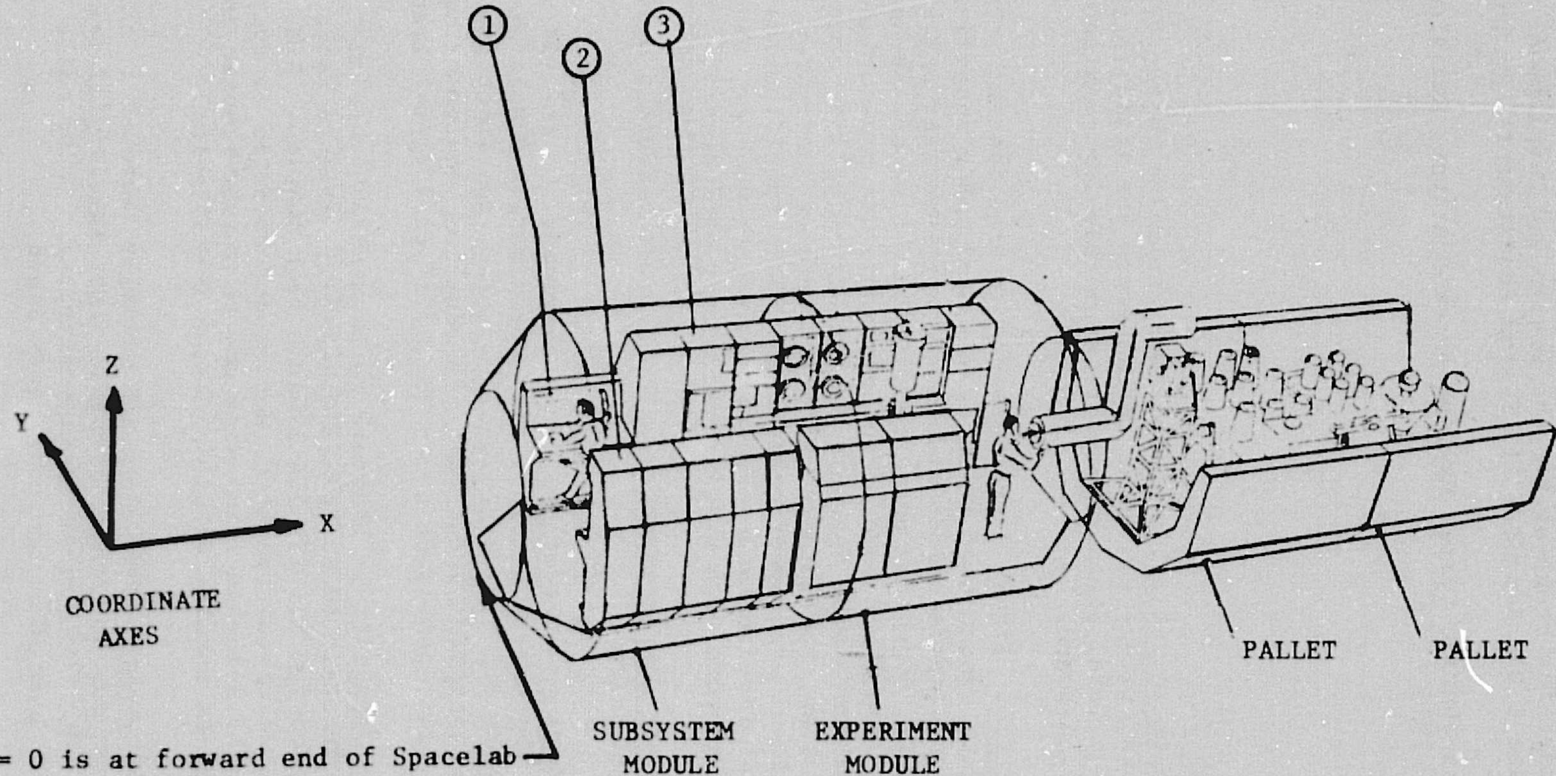
3.1.1.2 Experimenter Support Characteristics. The support resources available to combined experimenter payloads follow.

3.1.1.2.1 Equipment Physical Accommodations. Approximately 500 ft^3 (14 m^3) is available above the floor in the short Spacelab, and approximately 800 ft^3 ($\sim$22 m^3) is available in the larger Spacelab for rack/bench/shelf-mounted experiment equipments. Refer to Figure 1 for example equipment locations. In addition, equipment may be attached to the underside of floor panels at up to 35 lb/ft^2 (172 kg/m^2) loading. (1)

3.1.1.2.1.1 Rack Mounting Capability. Standard racks are available that can accommodate equipments up to approximately 60 lb/ft^3 (300 kg/m^3). Standard racks tie into Spacelab structure and are sized for MIL-STD-864 19-inch rack modules. NIM, ATR, ARINC 404 or MIL-STD-172 type electronic packages may be accommodated in appropriate substructure. Packages up to 39.3 inches (1 m) wide may be custom-mounted in double wide racks/shelves. Larger sizes require detailed design installation. (1)

3.1.1.2.1.1.1 Component Mounting. Components are normally fastened to their rack with screws through the front-mount surface. Equipment front panels will prevent mixing of rack cooling air with cabin air, minor leakage excepted. Guide rails with rigid-mate support fixtures are available for long/heavy items. (1)

3.1.1.2.1.1.2 Standard Rack Module Size. Maximum component size (less mounting surface) is 17-1/2 in. wide x 30 in. deep x height (0.44 m x 0.76 m x height). (1)



X = 0 is at forward end of Spacelab

(13) Y = 0 is Orbiter Y_0 = 0

Z = 0 is Orbiter Z_0 = 400

(1) WORK BENCH

(2) CONTROL CENTER

(3) MODULAR EQUIPMENT RACK

FIGURE 1. SPACELAB IN ORBITER ILLUSTRATING POTENTIAL GENERAL EXPERIMENTER OCCUPANCY REGIONS AND AXES COORDINATE SYSTEM

3.1.1.2.1.2 Equipment Stowage Boxes. Standard stowage containers that meet required safety and crew habitability requirements will be available to stow equipments, as required, in standard 19-in. rack widths. Stowage may be at various Spacelab locations. Custom boxes up to 39.3 in. (1 m) in width may be utilized. Containers may be packed by experimenters and direct-loaded onto Spacelab provided that a certification is completed which states the absence of flammability/explosion/corrosive/toxicity hazards and/or appropriate hazard isolation and cleaning procedures have been implemented. Fitted foam materials meeting flammability, off-gassing and contamination requirements may be used as separators and environment isolators within the stowage boxes. (1)

3.1.1.2.2 Electrical Power. Total power available to experiment equipments cannot exceed 4 kW continuous, or 9 kW peak for 15 minutes every 3 hours. Greater demands require special primary power sources to be added. The power forms available to experimenter equipments are provided below. (1) (2) (14) (13)

Basic

- 24 to 32 vdc, 1 v P-P ripple: Orbiter 28 vdc plus booster battery and limiter to eliminate transients
- 115/200 vac ± 5%, 400 Hz ± 1 Hz: Spacelab dc-ac converters, 3-phase Y-connected, 5% harmonics, 20% maximum phase-to-phase load unbalance usable as single phase

Add-on

- 115 vac ± 5%, 60 Hz ± 1 Hz, 5% harmonics: Spacelab dc-ac converters, single phase
- 220 vac ± 5%, 50 Hz, ± 1 Hz, 5% harmonics: Spacelab dc-ac converters, single phase
- 28 vdc ± 2%, 50 mv rms ripple: Spacelab dc-dc converters

Maximum continuous power from each secondary power source can be adjusted by adding converters.

3.1.1.2.2.1 Emergency Battery. An emergency battery is available to power only critical Spacelab subsystems and the caution and warning network. (1) (2)

3.1.1.2.2.2 Power Control and User Access. Power panels are conveniently located with circuit breakers and switchable to protect the power sources and to provide for emergency disconnect. (1)

3.1.1.2.2.3 Launch, Reentry and Landing Power. Experimenter equipment will normally be OFF during launch, reentry and landing. A total of 1 kW continuous, 1.5 kW peak, will be available for Spacelab subsystems and experimenters with critical power needs during these phases of operation. (1) (2)

3.1.1.2.2.4 Ground Checkout Operation. Integration and ground test operations in the Spacelab are supported by a GSE Orbiter power source simulator that provides power to on-orbit operation specifications.

3.1.1.2.3 Data Management and Control Functions. A dedicated data management and control subsystem is provided by Spacelab for experimenter use. Provisions are made for input and control, tape storage, display, playback and transmit. (1) (2) (13)

3.1.1.2.3.1 On-Board Data Management Capability. The basic total capability to support all experiments on a Spacelab mission follows.

- Sensors accepted - Up to 512 digital or converter analog signals
- Discrete signals accepted - Up to 512 binary-level signals
- Combined sensor data rates - Up to 30 Mbps digital
- Wideband analog inputs - 5 channels of 6 MHz bandwidths each
- Digital data storage - 4 x 10^{10} bits/reel at up to 30 Mbps
- Analog data storage - 30 minutes/reel dc to 6 MHz
- Computer memory - 32K or 64K 16-bit words

3.1.1.2.3.2 Data System-Experimenter Interface. Current concepts provide standard remote acquisition and control units (RAU's) for direct connection of individual sensors for analog-to-digital conversion and multiplexing/data formatting to a compatible data bus. Up to 8 RAU's, each accepting up to 64 analog and 64 discrete inputs, are available. Command and control are routed through the RAU's.

3.1.1.2.3.3 Ground Communications. Downlink data transmission is normally handled via the Shuttle subsystems. The following total basic capability is provided.

Downlink

- PCM Digital

  25 kbps through TDRS/STDN
  256 kbps through STDN
  50 Mbps through TDRS (KU-Band)

- Analog

  TV (color) through STDN or TDRS (KU-Band)
  Combined data (6 MHz bandwidth) through TDRS (KU-Band)
  [Alternate to TV through TDRS (KU-Band)]

- Voice

  2 channels, one dedicated to payload, through STDN or TDRS/STDN

Uplink

- Voice

  2 channels, one dedicated to payload, through STDN or TDRS/STDN

- Command

  2 kbps through STDN or TDRS/STDN

- TBD digital and analog data through TDRS (KU-Band)

3.1.1.2.3.4 Ground Checkout Operation in Spacelab. On-orbit operation is simulated.

3.1.1.3 Spacelab Internal Environments.

3.1.1.3.1 Normal Atmosphere. Atmospheric pressure throughout a mission, from launch to landing, is maintained in the range of 14.7 $\pm$ 0.25 psia.

3.1.1.3.1.1 Atmospheric Composition. Launch-to-landing atmospheric composition is nominally equivalent to sea-level air (21 parts oxygen to 79 parts nitrogen, 760 $\pm$ 13 mmHg), with maximum carbon dioxide of 7.6 mmHg partial pressure. Other elements as listed below (due to materials off-gassing, etc.) can be expected. Ground integration operations utilize ambient earth atmosphere conditioned to be compatible with

operational requirements (moisture, particles, etc.). Nominal air movement is 5 to 12 meters per minute.

3.1.1.3.1.2 Humidity. Maximum operational relative humidity will be 70 percent with the temperature of all points of the Spacelab interior above the dew point. Ground storage of Spacelab permits relative humidities of between 20 and 90 percent. (13) (14)

3.1.1.3.1.3 Contamination Levels.

3.1.1.3.1.3.1 Particles. The Spacelab environment will be maintained at a Class 100,000 environment per Federal Standard 209A up to launch. Subsequent to launch, Spacelab filtration removes particles larger than 5 microns. (13)

3.1.1.3.1.3.2 Chemicals. The following contaminants may be present (but not worst effect additive) up to the indicated maximum concentrations in milligrams per cubic meter in flight or ground operations. (1) (12)

ACETONE	240	CUMENE	25
ACETALDEHYDE	36	CYCLOHEXANE	100
ACETIC ACID	2.5	CYCLOHEXENE	100
ACETYLENE	180	CYCLOHEXANOL	20
ACETONITRILE	7	CYCLOPENTANE	100
ACROLEIN	0.25	CYCLOPROPANE	100
ALLYL ALCOHOL	0.5	CYANAMIDE	45
AMMONIA	3.5	DECALIN	5.0
AMYL ACETATE	53	1,1 DIMETHYL CYCLOHEXANE	120
AMYL ALCOHOL	36	TRANS 1,2 DIMENTHYL CYCLOHEX	120
BENZENE	8	2.2 DIMETHYL BUTANE	93
N-BUTANE	180	DIMETHYL SULFIDE	15
ISO-BUTANE	180	1,1 DICHLORO ETHANE	40
BUTENE-1	180	DI-ISO-BUTYL KETANE	29
CIS-BUTENE-2	180	1,4 DIOXANE	36
TRANS-BUTENE-2	180	DIMENTHYL FURAN	3.0
1,3 BUTADIENE	220	DIMETHYL HYDRAZINE	0.1
ISO-BUTYLENE	180	ETHANE	180
N-BUTYL-ALCOHOL	30	ETHYL ALCOHOL	190
ISO-BUTYL-ALCOHOL	30	ETHYL ACETYLENE	180
SEC-BUTYL-ALCOHOL	30	ETHYL BENZENE	44
TERT-BUTYL-ALCOHOL	30	ETHYLENE DICHLORIDE	40
BUTYL ACETATE	71	ETHYL ETHER	120
BUTRALDEHYDES	71	ETHYL BUTYL ETHER	200
BUTYRIC ACID	14	ETHYL FORMATE	30
CARBON DISULFIDE	6	ETHYLENE	180
CARBON MONOXIDE	29	ETHYLENE GLYCOL	114
CARBON TETRACHLORIDE	6.5	TRANS 1, METHYL 3 ETHYL C	117
CARBONYL SULFIDE	25	ETHYL SULFIDE	97
CHLORINE	1.5	ETHYL MERCAPTAN	2.5
CHLOROACETONE	100	FREON 11	560
CHLOROBENZENE	35	FREON 12	500
CHLOROFLUORMETHANE	24	FREON 22	350
CHLOROFORM	24	FREON 23	12
CHLOROPROPANE	84	FREON 113	700
CAPRYLIC ACID	155	FREON 114	700

FREON 114 (UNSYM)	700	PROPYLENE	180
FREON 125	25	ISO-PENTANE	295
FORMALDEHYDE	0.6	N-PENTANE	395
FURAN	3	PENTENE-1	180
FURFURAL	2	PENTENE-2	180
HYDROGEN	215	PROPANE	180
HYDROGEN CHLORIDE	0.15	N-PROPYL ACETATE	84
HYDROGEN FLUORIDE	0.08	N-PROPYL ALCOHOL	75
HYDROGEN SULFIDE	1.5	ISO-PROPYL ALCOHOL	98
HEPTANE 9	200	N-PROPYL BENZENE	44
HEXENE-1	180	ISO-PROPYL CHLORIDE	260
N-HEXANE	180	ISO-PROPYL ETHER	120
HEXAMETHYLCYCLO-THRISILOHEXANE	240	PROPRIONALDEHYDE	30
INDOLE	126	PROPIONIC ACID	15
ISOPRENE	140	PROPYL MERCAPTAN	82
METHYLENE CHLORIDE	21	PROPYLENE ALDEHYDE	10
METHYL-ACETATE	61	PYRUVIC ACID	0.9
METHYL-BUTENE	1430	PHENOL	1.9
METHYL FURAN	3	SKATOL	141
METHYL ETHYL KETONE	59	SULFUR DIOXIDE	0.8
METHYL ISOBUTYL KETONE	41	STYRENE	42
METHYL ISOPROPL KETONE	70	TETRACHLOROETHYLENE	67
METHYL CYCLO HEXANE	200	TETRAFLUORETHYLENE	205
METHYL ACETYLENE	165	TETRAHYDROFURANE	59
METHYL ALCOHOL	26	TOLUENE	75
3-METHYL PENTANE	295	TRICHLOROETHYLENE	
METHYL METHACRYLATE	41	1,2,4 TRI METHYL BENZENE	49
METHANE	1720	1.1.3 TRI METHYL CYCLOHEX	140
MONO METHYL HYDRAZINE	0.035	VALERALDEHYDE	70
METHYL MERCAPTAN	2	VALERIC ACID	110
NAPTHALENE	5.0	VINYL CHLORIDE	130
NITRIC OXIDE	32	VINYL METHYL ETHER	60
NITROGEN TETROXIDE	1.8	VINYLDENE CHLORIDE	20
NITROGEN DIOXIDE	0.9	O-XYLENE	44
NITROUS OXIDE	47	M-XYLENE	44
OCTANE	235	P-XYLENE	44

3.1.1.3.1.4 Emergency Conditions Atmosphere. The Spacelab can be depressurized in space to near vacuum within TBD minutes if necessary to combat fire, smoke, and toxics. Experiment equipments are not required to operate after a depressurization.

3.1.1.3.2 Spacelab Internal Temperatures. The following temperatures can occur inside the Spacelab:

- Air Temperature: Adjustable 65 F to 85 F $\pm$ 2 F (19 C to 26 C $\pm$ 1 C)
- Wall Temperature: 38 F (3 C) to 118 F (48 C)
- Ground Storage or Nonoperating: 40 F to 130 F (4 C to 55 C)

Exposed equipment surfaces shall have touch temperatures of less than 115 F (46 C).

3.1.1.3.2.1 Equipment Cooling. Coldplates and forced-air cooling provided by standard Spacelab facilities with the following controlled characteristics can be assumed (with equipment operating or nonoperating):

- Rack cooling air temperature: 79 F to 84 F (26 C to 29 C) (Cooling air isolated from cabin air)
- Maximum coldplate temperature: 104 F (40 C) (Requires Spacelab interface coordination.)

3.1.1.3.3 Shock, Vibration, and Acceleration. The following describes the random and sinusoidal vibration spectrums and steady-state and/or very low frequency acceler- (1) ations that equipments mounted within Spacelab may encounter during launch, reentry, and landing as transmitted from the Orbiter through the Spacelab mounting and structure dynamics. Controls on all ground handling will limit these inputs to values less than worst-case flight values.

3.1.1.3.3.1 Accelerations. Equipment accelerations are the same as specified for Orbiter (see Figure 1 for axes orientation). Maximum values throughout the mission (launch to landing) are as follows:

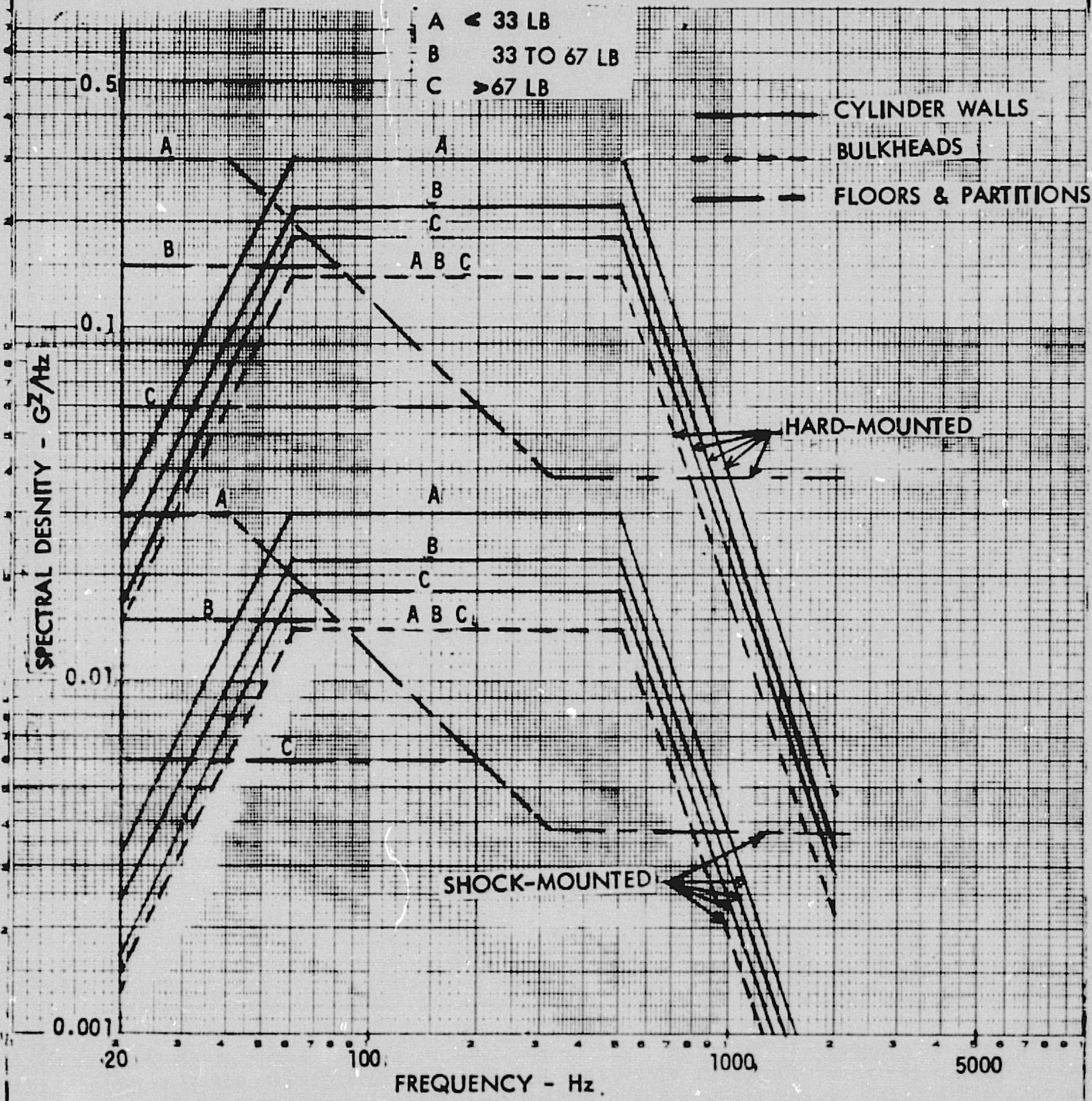
	X-AXIS	Y-AXIS	Z-AXIS	
. Maximum g's (normal launch, reentry, landing)	-3.3 +1.5	±1.5	+3.0 -1.0	
. Crash landing (hold-down and restraint fixture limit)	+9.0 -1.5	±1.5	+4.5 -2.0	(15)

3.1.1.3.3.2 Random Vibration. The vibration seen by the modules within Spacelab depends upon their rigid-body clustering masses, location of mountings to Spacelab, and whether or not shockmounts are employed. Table I summarizes the G rms values over the (1) 20 to 2000 Hz-band for three weight group categories, three Spacelab mounting locations, (13) and for both with and without shock mounts. Figure 2 provides spectral density characteristic curves.

TABLE I. G RMS OVER THE RANGE OF 20 TO 2000 Hz (ANY AXIS)

LOCATION IN SPACELAB	G RMS FOR INDICATED GROUP WEIGHTS		
	< 33 LB	33 TO 67 LB	> 67 LB
HARD-MOUNTED			
CYLINDRICAL AREAS	14.0	11.7	10.6
BULKHEAD AREAS	10.6	10.6	10.6
WALLS AND FLOORS	9.7	9.5	9.1
SHOCK-MOUNTED			
CYLINDRICAL AREAS	4.4	3.7	3.3
BULKHEAD AREAS	3.3	3.3	3.3
WALLS AND FLOORS	3.1	3.0	2.9

3.1.1.3.3.3 Sinusoidal Vibration. All weight groups, whether hard- or shock-mounted, may experience sinusoidal vibrations as given by Table II (in addition to (1) the random vibration of paragraph 3.1.1.3.3.2 and accelerations of paragraph 3.1.1.3.3.1), throughout the Spacelab during launch and reentry periods.



(1)

FIGURE 2.

SPECTRAL DENSITY CURVES FOR INDICATED RIGID-BODY MASSES, SPACELAB MOUNTING LOCATIONS AND SHOCK MOUNTING

TABLE II. SINUSOIDAL VIBRATION CHARACTERISTICS IN SPACELAB

AXIS	FREQUENCY (Hz)	AMPLITUDE
X	3 TO 8.5 8.5 TO 35 35 TO 50	0.8-INCH DOUBLE AMPLITUDE ±3.0 G PEAK TO PEAK ±1.0 G PEAK TO PEAK
Y AND Z	3 TO 7 7 TO 35	0.8-INCH DOUBLE AMPLITUDE ±2.0 G PEAK TO PEAK

3.1.1.3.3.4 Shock. Shock transmitted by Spacelab structure in flight or on the ground will not exceed the vibration/accelerations anticipated for the flight environment. (1)

3.1.1.3.4 Acoustic Noise Levels within Spacelab. The noise levels within Spacelab (14) interior during launch and reentry phases are as defined in Figure 3. These are the maximum levels over complete missions. The on-orbit working audio noise levels from all combined sources will not exceed the values of the NC-50 curve on standard noise criteria (NC) curves. This curve is approximately defined by 73 dB at 20 cps, linearly decreasing to 55 dB at 300 cps to 47 dB at 4800 cps (dB referenced to 0.0002 microbar).

3.1.1.3.5 Atomic Radiation. Radiation levels, from natural or other sources, (1) within Spacelab are low enough for safe human exposure. Therefore, equipment operation is not physically affected except where principle of operation is affected by background counts such as sensitive films, etc. Film vault storage will be provided.

3.1.1.3.6 Electromagnetic Interference (EMI).

3.1.1.3.6.1 EMI Generator Control. The net effect of radiated and conducted EMI caused by Spacelab subsystems and experimenter equipments will be controlled by observing good design practices for grounding, shielding, signal and power transmission (14) wiring, and bonding impedance. The intent is to achieve a 6-dB minimum safety margin between maximum imposed EMI levels and operative threshold levels of affected circuits in accordance with SL-E-0001 and SL-E-0002.

3.1.1.3.6.2 EMI Susceptibility. Equipment will nominally be required to be able to operate in EMI environments in accordance with SL-E-0001 and SL-E-0002 with a 6-dB (1) safety margain between the maximum environment levels and operating thresholds.

3.1.1.3.7 Zero-G Effects. The resultant average acceleration of Spacelab is zero in all axes while on orbit (no artificial gravity). Minor perturbations between 10^{-2}g (13) and 10^{-3}g may occur resulting from crew movement, manipulator activation, water pumps, etc. During attitude maneuvers, accelerations of up to -0.2 and +0.1 g along the X axis and ±0.1 g along the Y and Z axes may occur.

3.1.1.4 Spacelab Safety Provisions. The following, in conjunction with minimum (15) requirements to be met by equipment brought on board, provides for crew and Orbiter-Spacelab safety.

3.1.1.4.1 Caution and Warning (C&W) Devices. Identified potential flammability, toxicity and contamination hazards require warning devices to allow sufficient time for (1) corrective action. Such warning devices operate independently from other operational (14) circuitry and power supplies. Spacelab provides fire, smoke and toxics warnings for

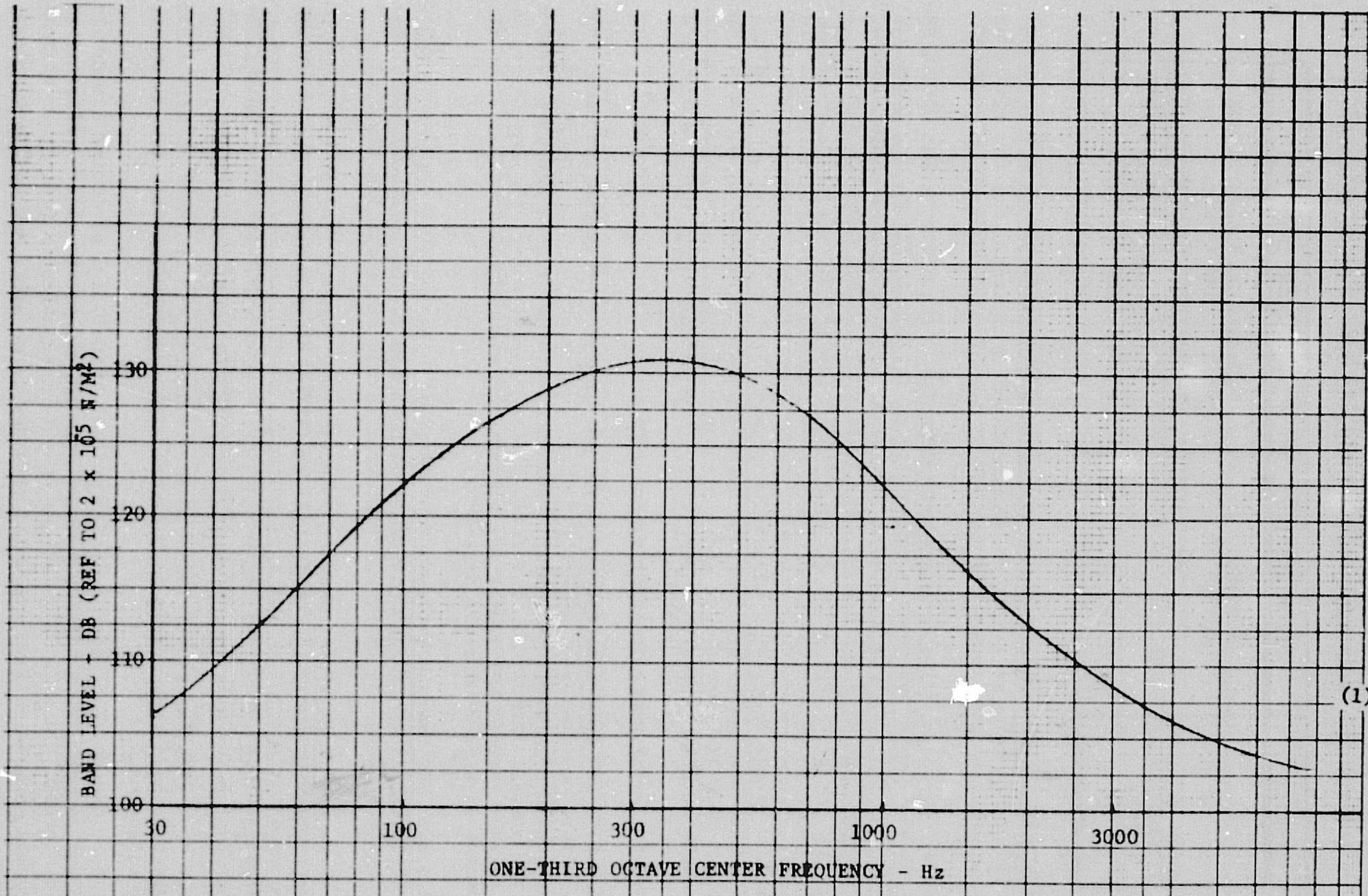


FIGURE 3. ACOUSTIC NOISE INSIDE SPACELAB

the general environment. Hazardous experiment equipment requires additional caution/warning sensors to be integrated into the monitoring and control subsystem to enable appropriate visual and audio alarms when critical tolerances are exceeded (caution) and when immediate corrective action is needed to prevent injury or loss of personnel/equipment (warning).

3.1.1.4.2 Fire Extinguishers. At least three Apollo-type fire extinguishers will be strategically located throughout Spacelab. (1) (14)

3.1.1.4.3 Depressurization. In emergencies the Spacelab may be depressurized in TBD minutes. The Orbiter provides a safe haven for Spacelab crew members. Equipments must not erupt with new hazards upon such depressurization and subsequent repressurization. (1) (14)

3.1.1.4.4 Oxygen Masks. Oxygen masks and 30-minute portable oxygen supplies will be available if the atmosphere becomes unsafe for personnel. (1) (14)

3.1.1.4.5 Shatterable Materials. All materials that could conceivably shatter for any specified Spacelab condition (including ground operations, depressurization, crash landing, launch and reentry forces) or credible accident, oversight, etc., shall be contained or constrained adequately to prevent debris and missiles from being emitted that could impair habitation quality or equipment operations, or cause injury or further damage. (1) (14)

3.1.1.4.6 Protrusions and Sharp Edges/Corners. All equipment surfaces exposed to bodily contact by personnel during normal operations shall have rounded (0.5-inch radius) edges and corners, or have guards or other protection to serve an equivalent function. (1)

3.1.1.4.7 Crash-Landing Provisions. All equipments are mounted, restrained or stowed to withstand the crash-landing loads of paragraph 3.1.1.3.3.1 without erupting hazardous fluids or releasing loose missiles or debris. (1)

3.1.1.4.8 Flammability. Spacelab structures and subsystem materials and design are equivalent to Orbiter design criteria and utilize materials rated "A" or "B" for use in air as defined by SD 72-SH-0127, "Space Shuttle Orbiter Materials Control and Verification Plan." Materials are flammability-rated "A" where noncombustible or self-extinguishing upward in air, without spark, drip or sputter of flaming particles within 6 inches of the point of ignition at the bottom of a vertically oriented specimen (per NHB 8060.1). Such "A" rated materials are suitable for unrestricted use in air. "B" rated materials for use in air have propagation downward rates in air of less than 0.3 in./sec and have flash and fire points greater than 450 F. "B" materials may be utilized providing that discrete quantities which could mutually support combustion are limited to less than 1 pound and 40 in.^{2} of surface area, or are in containers (with or without ignition sources) that prevent propagation of flames or burning debris. Materials exposed to LGOX, HGOX, LOX, N_2H_4, or other non-air environments are not covered in this document, and special requirements and evaluations may be required for such applications. (5)

3.1.1.4.8.1 Storage of Flammable Materials. Fire-proof storage is provided for stock and waste tissues, etc. (14) (1)

3.1.1.4.9 Off-Gassing, Toxics/Odors. Spacelab environmental protection requires controlling materials off-gassing similar to Shuttle requirements. In accordance with SD 72-SH-0172, materials rated "A" or "B" for toxicity are utilized. A material is toxicity-rated "A" if it has $\leq$ 250 micrograms per gram total organics, $\leq$ 50 micrograms per gram of carbon monoxide, and has an average odor rating $\leq$ 3.0, when tested per NHB 8060.1. A "B" material does not meet one or more "A" requirements, but will meet an "A" requirement in conjunction with specific controls such as coatings, hermetic sealing, etc.

3.1.1.4.9.1 Prohibited Materials. The following shall not be brought into Spacelab in any measurable quantity in any form:

- Mercury
- Methyl chloroform
- Cadmium

3.1.1.4.10 Physical Equipment Restraints. All materials, parts, and equipments shall be secured in such a way as to reliably prevent loose items from drifting or accelerating against or within other equipments or personnel in such a way as to cause damage, operational interference or injury for all mission modes and phases, including emergency modes.

3.1.1.4.11 Touch Temperatures. See paragraph 3.1.1.3.2.

3.2 Experimenter Equipment/Material Requirements.

3.2.1 Mandatory Safety Requirements. The following requirements are mandatory, unless specifically waived by Orbiter-Spacelab management, in order to ensure Orbiter-Spacelab and personnel safety.

3.2.1.1 Equipment Construction and Installation. The equipments and their constituent parts shall not shatter, come loose from their mountings, or erupt to generate flying missiles or release hazardous or corrosive substances when exposed to the crash environment of paragraph 3.1.1.3.3.1, or the random plus sinusoidal environments of paragraphs 3.1.1.3.3.2 and 3.1.1.3.3.3, for applicable mounting conditions, or during emergency depressurizations to near-vacuum and repressurization per paragraph 3.1.1.4.3. When the equipments are stowed in protective containers, the requirements apply to the stowage box and equipment combined. All materials and parts subject to accidental or intentional breakage during normal on-orbit operations that could result in missiles, abrasive or injurious particles, or release of toxics, corrosives or contaminants immediately or at a later mission time shall be constrained or guarded to preclude such possibilities. Parts and equipments shall be secured from drifting away or from unintended accelerations with positive mechanisms designed to function properly after exposure to launch environments.

3.2.1.1.1 Sharp Corners, Edges, Protrusions. All equipment surfaces exposed to personnel operations shall not protrude into travel lanes and shall have rounded edges and corners or guards with 0.5-inch minimum radius to prevent bodily contact with edges/corners of lesser radii and protrusions that could cause injury.

3.2.1.2 Flammability. All equipments to be placed on Spacelab shall be evaluated for flammability. Equipments meeting requirements of paragraph 3.1.1.4.8 shall be acceptable for Spacelab. The current issue of Rockwell Space Division computerized material analysis tracking and control system reports [U719-10-206 and U719-10-209 (for non-metals) and U719-10-207 and U719-10-208 (for metals)] may be used as the basis for evaluating flight acceptability of equipments with respect to specific constituent materials. Unidentified materials as a minimum shall be upgraded to a verified "B" rating by approved coating, replacement, or other means, except that unidentified materials in a completely enclosed unit that precludes the escape of potentially flaming particles need not be upgraded.

3.2.1.3 Toxicity. Usage of materials in equipments that conform to "A" or "B" ragings per paragraph 3.1.1.4.9 shall be acceptable to place on board Spacelab. The materials analysis tracking and control reports (U719-10-206 and U719-10-209) for exposure categories A and B shall be utilized to evaluate equipment material toxicity. Materials rated "A" may be utilized unrestricted. Materials rated "B" may be utilized without controls (coatings, etc.) to the extent that the total organics and carbon monoxide per equipment or group of equipments do not exceed the values that could result if the equipment consisted of all "A" materials containing maximum allowable organics and carbon monoxide. Before being placed in the Spacelab, items shall be operated or otherwise "baked out" for a sufficient time period to drive off excessive surface gases that may reside due to manufacturing or cleaning processes.

3.2.1.4 Electric Shock. External housings shall be grounded to preclude shocks to personnel from either electrical leakage or static charge buildup. Grounding satisfying EMI requirements will satisfy this requirement.

3.2.1.5 Caution and Warning Networks. Any potential hazard to crew or total Spacelab shall be instrumented to provide "0" or "1" state (safe or caution/warning) signals to the Spacelab caution and warning network. This network operates from an independent power supply. The Spacelab operations management will integrate the signal into the C&W network as warranted by the degree and conditions for which a hazard exists.

3.2.2 Mandatory Environmental Preservation Criteria. The following requirements are mandatory in order to maintain a nominal Spacelab environment for all experimenter payloads and to assure Spacelab subsystems performance.

3.2.2.1 Materials and Construction. Equipments meeting the safety requirements of applicable subparagraphs of paragraph 3.2.1 above will meet requirements of this section. Calculated verification of structural safety is acceptable providing that yield and ultimate safety factors are at least 2 and 3 respectively. Liquid and gas lines up to 1.5-in. diameter are satisfactory if ultimate pressure ratings are at least 4 times peak limit pressure, and if lines are unpressurized during launch and reentry. Liquid lines shall not be exposed to provide possible hand rails or obstacles to personnel/equipment movement.

3.2.2.2 Contamination Generation.

3.2.2.2.1 Particles. Equipment and packing materials shall be subjected to a cleaning operation compatible with installation in a Class 100,000 area prior to on-loading into Spacelab (whether or not in stowage containers). Exterior or non-sealed interior of equipments shall have coatings or finishes that do not show visible signs of flaking or peeling.

3.2.2.3 Acoustic Noise. Individual equipment items shall not emit audible noise greater than 40 dB in order to meet the Spacelab requirement in paragraph 3.1.1.3.4. However, occasional noise levels up to 80 dB for 3 minutes are permitted (i.e., fast tape rewind, etc.). Values are for 2 feet from accessible areas when installed for operation.

3.2.2.4 EMI Susceptibility and Radiation. Equipment units that facilitate the Spacelab design practices below are considered to meet the requirements of paragraph 3.1.1.3.6. Only those practices necessary to prevent transmission of excessive conducted and radiated interference external to equipments or to assure operability in the Spacelab environment as a consequence of Spacelab design practices are provided. Internal interference shielding practices not relevant to external interfaces are the user's responsibility.

3.2.2.4.1 Grounding and Signal Circuits. Equipment input/output connectors and input/output circuits shall facilitate the following practices:

a. Spacelab, rack or equipment structures shall not be used as signal or power returns.

b. Separate power grounds shall be returned to each Spacelab power source panel connection and shall not be switched.

c. Signal and power returns shall not be shared.

d. All equipment cases, enclosures and chassis shall facilitate electrical bonding to the vehicle structure with bonds not exceeding 10 milliohms dc impedance.

e. No signal or power ground shall be connected with less than 1 megohm dc impedance to a chassis or case that is separately returned to structure ground. A chassis connected directly to signal ground shall be isolated from case ground to prevent system ground loops. Isolated chassis requires isolation from personnel contact where a potential shock or external short-circuit hazard could exist.

f. Shield grounds shall be brought directly to the structure or case ground, using conductive epoxy, halo rings, or equivalent methods. Shields shall not be connected to a common wire and grounded at a remote point.

g. Output impedances shall be less than 10K ohms and full-scale signal voltages at least 5 volts from ground reference.

h. Use coaxial cable or twisted shielded pairs for outputs with frequency components greater than 150 kHz.

i. Use separately returned shielded pairs or coax for signals where rise/fall rates of change are greater than 30 MA per microsecond and where maximum signal level is 30 MA or more.

3.2.2.4.2 Shielding (Generator or Receptor).

3.2.2.4.2.1 Signal Shields. Signal wire shields shall have the option of grounding or not grounding at a particular equipment input or output connector. Internal signal shielding shall be grounded internally and not rely upon connector feedthrough. Connector feedthrough shall be available to ground external shields internally for signals requiring them.

3.2.2.4.2.2 Metal Shields. Equipment external cases shall be of metal of at least 0.040 inch thickness that effectively encloses the unit in order to attenuate E-field and plane wave radiation and H-field radiation above 10 kHz. In addition, a thin copper shield may be required to maximize attenuation in the region of 60 Hz to 10 kHz for large current flows ($\sim$ 10 amp). External case shields shall not have openings that permit unattenuated radiation. Separate sections of the case shield shall be bonded or bolted, at intervals not exceeding 4 inches, through positive bare metal or conductive coating pressure contacts, or equivalent practices. RFI gaskets or equivalent may be required on some items.

3.2.2.4.3 Power Turn-On

a. Turn-on in-rush current shall not exceed 2-1/2 times the steady-state value.

b. Current rise times should not exceed 5 microseconds, and ringing should not exceed 5 cycles to reach $\pm$5 percent of steady state.

3.2.2.4.4 Output Signal Characteristics.

a. Rise and fall times of digital signals shall be controlled in order to minimize unwanted EMI coupling.

b. Rise and fall times should be larger than twice the propagation delay of the line from driving to receiving circuit if the line is not terminated in its characteristic impedance.

3.2.3 Typical Operating Requirements. The following criteria are solely the equipment user's responsibility. The criteria should be adequately considered to ensure successful completion of the experimenter's objectives. As a minimum, the equipment and/or its packaging should be designed to survive approximately a 3-minute launch, and operate over the required on-orbit duty cycle duration. Reuse on subsequent missions requires design/refurbishment for repeated launch and operational periods plus reentry and landing phases of approximately 15 minutes each (where worst-case vibration/acceleration may occur).

3.2.3.1 Equipment Size. To avoid delays and expense for custom-mounting racks and stowage containers, selected equipment items should conform to the standard sizes referenced in paragraph 3.1.1.2.1 and subparagraphs. While mass and volume are not critical, wherever practical, smaller sizes should be chosen consistent with integration with other equipments and objectives.

3.2.3.2 Electrical Power. Equipments shall be required to operate on one or more of the voltages identified in paragraph 3.1.1.2.2. The amount of power allotted to each equipment is not directly specified; however, the total power used by all users cannot exceed the value specified in paragraph 3.1.1.2.2, and the integrated loads on the 3-phase ac must remain within 20 percent between phase legs. Any one item that could use more than 1 kW peak shall consider means to reduce needs. Power during launch and reentry and landing shall only be utilized for critical purposes, to be identified and coordinated with Spacelab operations management. Only necessary caution and warning circuits will be accessible to emergency battery power.

3.2.3.3 Data Management and Command Control Compatibility. Outputs to be multiplexed or direct recorded through Spacelab remote data acquisition units (RAU's) require voltages in the range of 5 to 12 volts from ground reference for digital/discretes 1-state levels or analog full-scale levels. Scaling will be done in the data acquisition units. Output driver impedance shall be less than 10K ohms. Commands from RAU's will be 0 or 5 to 12 volts nominal at $\leq$ 1K ohm output impedance.

3.2.3.4 Atmosphere. Equipment will be exposed to an equivalent-air or air atmosphere per paragraph 3.1.1.3.1 and subparagraphs. The normal atmosphere also may contain the particle and chemical contaminants in paragraph 3.1.1.3.1.3.

3.2.3.5 Ambient Temperatures. Equipments shall withstand the operational and ground storage ambient air temperatures of paragraph 3.1.1.3.2.

3.2.3.6 Equipment Cooling. Where forced-air or coldplate operation is required, the equipment shall be capable of satisfactory operation with the cooling temperatures provided for by paragraph 3.1.1.3.2.1.

3.2.3.7 Shock, Vibration, Acceleration and Acoustic Noise. As a minimum, equipment shall operate satisfactorily for the duration of the mission after 3 minutes exposure to combined acceleration and random and sinusoidal vibrations of paragraph 3.1.1.3.3 and subparagraphs, plus the acoustic noise levels of paragraph 3.1.1.3.4.

3.2.3.8 Atomic Radiation. Atomic radiation from natural sources is well below the levels of any significance to equipment survival. Experiment equipment which emits radiation will be shielded to prevent impact to other experiment equipment. Equipments sensitive to radiation-induced noise or signals are the responsibility of the experimenter.

3.2.3.9 Contamination Susceptibility. The equipment shall be capable of operation for its total useful life in the particle and chemical environments of paragraph 3.1.1.3.1.3.

3.2.3.10 Zero-G Effects

3.2.3.10.1 Thermal Dissipation. Equipment points of power dissipation shall have adequate thermal conductance paths where forced-air convection cannot be relied upon. The effects of lack of gravity must be considered for points of power dissipation in "dead" air zones where positive thermal paths are not adequate. Equipments without provisions for internal-external air circulation that are designed to operate at 50,000 feet, relying on internal conduction to transfer heat to the external case, can be assumed to be acceptable. Equipments with self-contained fans and direct air flow over components or their heat sinks can be assumed acceptable. Components mounted on insulators in dead air spaces require cooling provisions if the dissipation on the insulator (circuit board) exceeds 2 watts per 20 square inches of circuit board area provided good contact or a hemispherical view to metallic structure exists. Density of electrical conductors that provide good conductance paths to reduce the effective thermal resistance can be used to justify increasing the foregoing dissipation rule.

3.2.3.10.2 Gravity-Dependent Functions. Equipment functions that relay upon gravity such as mechanical seating, containing liquid, material feed constraints, etc., require redesign for operation in weightless environments. Redesign should consider hysteresis effects on such as repeatability of operation.

3.2.3.10.3 Loose Accessories. Common table-top accessories or attachments such as adjusters, eyepieces, etc., must be provided with positive detents, lanyards, etc., to prevent loose items in Spacelab.

4.0 PROCESS CONTROLS

4.1 Process Controls. Manufacture and test of experimenter equipment is the responsibility of the experimenter as he deems necessary to achieve his objectives and to verify meeting mandatory requirements of paragraph 3.2.1.

5.0 TEST AND VERIFICATION

5.1 Test and Verification. All experimenter equipment tests prior to integration are the responsibility of the experimenter, except as necessary to verify meeting the mandatory safety and environmental preservation requirements of paragraphs 3.2.1 and 3.2.2. Requirements of paragraphs 3.2.1 and 3.2.2 not met will result in the equipment not being allowed on Spacelab or operation being restricted to times when it will not adversely affect other equipment operations.

5.2 Off-Gassing. Where an assessment of specific materials in an equipment is not practical, an overall equipment test TBD may be performed to establish compliance. A general policy shall be implemented of operating equipment for an equivalent 150 hours normal operation after purchase or solvent cleaning to drive off the largest practical amount of out/off gases before taking into Spacelab.

5.3 EMI Tests. Equipment EMI generation and susceptibility tests may be accomplished in accordance with MIL-STD-462 to assure ability to operate unrestricted or to establish an operating plan to permit objectives to be achieved.

6.0 OTHER EQUIPMENT CONSIDERATIONS

6.1 Other Equipment Considerations. Equipment effectiveness factors such as reliability, maintainability, spares/maintenance equipment, reusability, etc., are the user's responsibility. On-orbit maintenance should be limited to simple replacement of plug-in-type modules.

APPENDIX E

NASA GENERAL EQUIPMENT SPECIFICATION

EC006M00000A

EC 006M00000 A
January 1973

GENERAL EQUIPMENT SPECIFICATION

PART I

PERFORMANCE, DESIGN AND

VERIFICATION REQUIREMENTS

FOR

EXPERIMENT AND GENERAL LABORATORY EQUIPMENT

TO BE SELECTED

FOR

PROJECT SORTIE LAB

APPROVED BY ______________________
(Preparing activity)

DATE ______________________

APPROVED BY ______________________

DATE ______________________

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1.0 SCOPE

This specification establishes the requirements for performance, design and verification of existing commercially available or off-the-shelf Experiment and General Laboratory Equipment, for orbital operation in a pressurized compartment in Manned Sortie Missions. Equipment which meets the quantitative performance requirements of this specification and which has particularly desirable attributes for a specific use, shall not be rejected from further consideration due to failure to meet a qualitative requirement contained herein. Candidate equipment may be selected for modification or by limited waiver of requirements. Typical equipment which may be procured to these requirements is listed in Section 6.0.

2.0 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced, and other detailed contents of this specification, the detailed requirements herein shall be considered superseding.

Document	Title	Referenced Paragraph
SPECIFICATIONS		
Marshall Space Flight Center		
MSFC-SPEC-101B March 15, 1971	Flammability, Odor, and Off-gassing requirements and Test Procedures for Materials in Environments which Support combustion.	3.2.6.3
Military		
MIL-F-14072A Sept. 11, 1968	Finishes for Ground Signal Equipment	3.3.9 Figure 1 Footnote 3
STANDARDS		
Military		
MIL-STD-461A(Not. 4) Feb. 9, 1971	Electromagnetic Interference Characteristics Requirements for Equipment	3.3.5.1
MIL-STD-462(Not. 3) Feb. 9, 1971	Electromagnetic Interference Characteristics, Measurement of	3.3.5.1

OTHER PUBLICATIONS

Atomic Energy Commission

Rules and Regulations

Title 10, Part 71 Dec. 31, 1968	Packaging of Radioactive Material for Transit	3.2.7.3

MISCELLANEOUS

Marshall Space Flight Center

10M 33222 August 15, 1972	Man/Systems Design Requirements for Sortie Lab	3.3.15

3.0 REQUIREMENTS

3.1 DEFINITION

3.1.1 GENERAL DESCRIPTION

The Experiment and General Laboratory Equipment shall consist of selected hardware and equipment to support experiments and experiment related activities and procedures to be employed in missions such as described in 3.1.2.

3.1.2 MISSIONS

Typical Sortie Lab missions consist of support for and conduct of experiments in the following general areas:

a. Astronomy: UV, IR, High Energy Stellar.

b. Physics: Space Physics (Orbital Environment) - Plasma Physics - Molecular and Chemistry Phenomena.

c. Earth Observations: Weather - Resources - Pollution.

d. Communications/Navigation: Optical Frequency Demonstration - Surveillance, Search, Rescue - Laser Ranging - Satellite Navigation for Terrestrial Users.

e. Materials Sciences/Manufacturing: Materials Composites, Casting, Crystal Growth - Supercooling - Biological Separation.

f. Technology: Contamination - EVA - Advanced Spacecraft Systems Tests - Teleoperations.

g. Life Sciences: Medical Research - Plant Research - Life Support - Manned System Integration.

3.1.3 OPERATIONAL CONCEPTS

3.1.3.1 Mission Duration: The equipment shall be required to operate during a mission of 7 to 30 days duration.

3.1.3.2 Equipment design shall be compatible with prelaunch and launch operations which dictate minimal access while on the launch pad. Any requirement for on-pad loading of equipment consumables or perishables shall be identified.

3.2 CHARACTERISTICS

3.2.1 PERFORMANCE

3.2.1.1 GENERAL PERFORMANCE

3.2.1.1.1 Commercially available or off-the-shelf equipment and hardware shall be utilized to the fullest extent possible, consistent with the requirements stated herein.

3.2.1.1.2 Equipment covered by this specification shall not be required to be operating during launch, reentry or landing.

3.2.1.2 ELECTRICAL FUNCTIONAL AREA

Type of Power: 28 VDC ± 4.0 VDC and 115/200 VAC ± TBD, 3Ø, 400 Hz.

NOTE: If 60 Hz power is required for an experiment or instrument, individual inverters will be provided as part of the experiment.

3.2.2 PHYSICAL

3.2.2.1 MASS PROPERTIES

Any limitations and restrictions are to be determined.

NOTE: A maximum weight of the equipment will be specified (specification weight).

3.2.2.2 DIMENSIONS AND VOLUMES

Any general limitations and restrictions are to be determined.

3.2.3 RELIABILITY

Non-catastrophic and non-propagating failures shall be permitted when compatible with individual experiment reliability goal.

3.2.4 MAINTAINABILITY

3.2.4.1 The design shall provide for accessibility, rapid fault isolation, ease of remove/replace activities, and the use of standard tools and test equipment. Ground maintenance shall be the normal mode of maintenance.

3.2.4.2 Consideration shall be given to location of test points and adjustments for ease of maintenance without disconnecting electrical connectors.

3.2.4.3 Accessibility and ease of operation of latches, lockdowns, fasteners, etc., shall be considered for ease of maintenance.

3.2.4.4 For units or components requiring frequent adjustments or for installation and removal of casettes, rolls, samples, film, etc., front panel access is desirable.

3.2.5 OPERATIONAL AVAILABILITY

Not Applicable

3.2.6 SAFETY

3.2.6.1 The equipment shall not degrade the safety of the Sortie Lab, Space Shuttle, Ground or Flight Personnel or violate safety levels and requirements stated herein either during normal operations, maintenance or failure modes.

3.2.6.2 The equipment shall contain no ordnance devices.

3.2.6.3 All materials flammibility, odor, and offgassing characteristics shall be identified for the application usage including relative locations, quantities and configurations as defined in MSFC-SPEC-101. The atmosphere pressures and gas mixtures shall be as specified in 3.2.7.2 herein for on-orbit operations.

Any materials which do not meet the criteria of MSFC-SPEC-101 for Group I must be approved by MSFC for use on an individual basis.

In lieu of performing any testing required by MSFC-SPEC-101, including batch/lot testing, materials lists with usage configurations may be submitted to MSFC for initial determination of acceptability. Results of any previous tests and supportative analyses may be submitted to MSFC for determination of compliance with the intent of MSFC-SPEC-101. Final evaluation and approval shall be conditioned on results of individual materials and/or end item configuration tests performed by or required by MSFC on an individual basis.

The requirement of MSFC-SPEC-101, pararagraph 3.1, Materials Control Plan, is deleted from equipment covered by this specification. The requirement of MSFC-SPEC-101, paragraph 3.2.2.1.1 for testing metallic materials for LOX/GOX compatibility shall only apply to equipment used in high pressure LOX/GOX systems (Type D usage defined in MSFC-SPEC-101, Table 1).

3.2.6.4 **Catastrophic and critical hazards whereby environment, personnel error, design characteristics, procedural deficiencies, or subsystem malfunction may result in loss of personnel capability or loss of system shall be eliminated or controlled by means of safety devices, warning devices or procedures. Residual hazards for which controls cannot be developed or provided shall be identified.**

3.2.7 ENVIRONMENT

3.2.7.1 Non-Operational

Temperature: -40°C to + 75°C (-40°F to + 167°F).

Pressure: 0-15 psia/Rate of Change Approx. 2 Min. from maximum P to minimum P

Atmosphere composition: 80% N_2; 20% O_2, $\pm$ TBD.

Relative Humidity: TBD

Acceleration: $\pm$ 4.5 g (all axes)

Launch Status: Passive

Contaminants: filter air to class 100,000 as defined in 3.3.10.1

Emergency Landing Shock:

	Longitudinal	Lateral	Vertical
	8g	4.5g	4.5g

Equipment need not operate thereafter, but shall retain package and mounting integrity.

Vibration: TBD
Acoustic: TBD
Shock: TBD

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OF POOR QUALITY

3.2.7.2 Operational

A nominal "shirt-sleeve" environment shall exist for equipment operation.

Temperature: 18°C to 29°C (65°F to 85°F)

Humidity: 45 ± 5% R.H. at 21°C (70°F)

Pressure: 14.7 psia ± 0.2 psi

Atmosphere Composition:

Total Pressure	14.7 psia
O_2 Partial Pressure	3.1 psia
CO_2 Partial Pressure	$<$7.6 mm Hg
H_2O Partial Pressure	6-11 mm Hg

Atmosphere Contamination:

Cleanliness: Class 100,000 as defined in 3.3.10.1

Maximum Methane Concentration $< 5 \times 10^{14} \frac{\text{Molecules}}{\text{CM}^3}$
(10 PPM by weight)

Maximum Hydrocarbons (Molecular Weight $>$ 200)
$< 10^{14} \frac{\text{Molecules}}{\text{CM}^3}$

Acceleration: $< 10^{-2}$ g's

Vibration: TBD

Touch Temperature: 3°C to 46°C (38°F to 115°F)
Equipment surface temperatures below 16° C (60°F) should be avoided to prevent atmospheric moisture from condensing on its surface.

Noise Level: Equipment and main equipment interfaces shall be compatible with an overall Sortie Module noise level less than the following:

Frequency Range (Hz)	Sound Pressure Levels
63	70 db
125	70 db
250	60 db
500	60 db
1000	55 db
2000	55 db
4000	55 db
8000	60 db
16000	60 db

Pure tone components shall be not more than 10 db above the octave band level containing the pure tone frequency.

3.2.7.3 **Radioactive Sources.** The quantities and/or concentrations of radioactive sources such as calibration sources and display dials shall not exceed the exemptions specified in USAEC Rules and Regulations, Title 10, Part 71, Paragraph 7.1.5. Also any equipment susceptible to radiation degradation shall be defined.

3.2.8 TRANSPORTABILITY/TRANSPORTATION

Equipment shall be compatible with commercial transportation systems.

Vibration and shock criteria - TBD

3.3. DESIGN AND CONSTRUCTION STANDARDS

3.3.1 SELECTION OF SPECIFICATIONS AND STANDARDS

Not Applicable

3.3.2 GENERAL

Not Applicable

3.3.3 AERONAUTICAL

TBD

3.3.4 CIVIL

Not Applicable

3.3.5 ELECTRICAL

3.3.5.1 Electromagnetic Compatibility (EMC) characteristics and measurements shall be in accordance with MIL-STD-461 and MIL-STD-462. The following frequency ranges shall be considered in establishing equipment emission and susceptibility levels. (Frequencies TBD)

3.3.5.1.2 Shorting clips or springs shall not be used in electrical or electronic connectors. Test equipment used shall be fitted with cable connectors that mate with the experiment equipment connectors or sockets. In no case shall socket connectors be connected by holding meter probes against the pins or by attachment of alligator clips.

3.3.5.1.3 All electrical connectors, plugs and receptacles shall be positively keyed to prevent incorrect connection with other accessible connectors, plugs and receptacles. Connectors and wiring junctions shall be sealed from moisture condensatio

3.3.5.1.4 There shall be safety interlocks where necessary to insure personnel safety.

3.3.6 MECHANICAL

3.3.6.1 Mechanical design shall generally meet the following requirements:

3.3.6.1.1 Material which can shatter, such as glass, shall not be used unless positive protection is incorporated to prevent fragments or dust from entering the habitable environment.

3.3.6.1.2 Surfaces which are expected to be exposed to continuous or extensive abrasion and rubbing by the crew shall not be painted or coated with materials that are subject to flaking or peeling.

3.3.6.1.3 Where possible, actuating devices shall be made an integral part of the equipment to be operated. Detachable items, such as handles, pins, and ratchets shall be secured by lanyards or similar devices which will not compromise crew safety.

3.3.6.1.4 Factors of Safety

3.3.6.1.4.1 Package integrity and structural mounting provisions load carrying capability shall be based on the following minimum factors of safety in lieu of performing static load structural testing:

Yield Factor of Safety	=2.0
Ultimate Factor of Safety	=3.0

3.3.6.1.4.2 Hydraulic and pneumatic systems, where used, shall meet the following minimum requirements:

(1) Lines and Fittings, less than 1.5 inch diameter

Proof Pressure	=2.0 x limit pressure
Ultimate Pressure	=4.0 x limit pressure

(2) Lines and Fittings, 1.5 inch diameter or greater

Proof Pressure	=1.2 x limit pressure
Ultimate Pressure	1.5 x limit pressure

(3) Hydraulic and Pneumatic Tanks & High Pressure Vessels

Proof Pressure	=1.5 x limit pressure
Ultimate Pressure	=2.0 x limit pressure

(4) Actuating Cylinder, Valves, Filters, Switches

Proof Pressure	=1.5 x limit pressure
Ultimate Pressure	=2.0 x limit pressure

3.3.6.2 MATERIALS

The following material requirements shall be in addition to the flammibility, odor and offgassing requirements of paragraph 3.2.6.3.

3.3.6.2.1 Equipment covered by this specification shall not contain mercury, liquid or gaseous halogenated hydrocarbons, or polyvinyl chloride (PVC).

3.3.6.2.2 Use of cadmium plating should be avoided in equipment containers subject to elevated temperatures (above 450°F) or where exposed cadmium in contact with breathing gas could reach temperatures that would generate toxic fumes such as might result from electrical short or fire.

3.3.7 NUCLEAR

Not Applicable.

3.3.8 MOISTURE AND FUNGUS RESISTANCE

All materials used shall be non-nutrient to fungus growth, or shall be treated so the exposed surfaces will be fungus resistant, except that nutrients may be used inside of enclosures that will be hermetically sealed. Methods of treatment for fungus resistance shall be compatible with the treated and adjacent materials.

3.3.9 CORROSION OF METAL PARTS

Metals shall be corrosion resistant or shall be processed to resist corrosion. Dissimilar metals shall not be used in intimate contact unless suitably protected against electrolytic corrosion. Compatible metal couples are defined in Figure 1. Any protective coating used shall meet the requirements of paragraph 3.2.6.3.

3.3.10 CONTAMINATION CONTROL

3.3.10.1 Equipment material or equipment finish shall not flake-off, generate dust or contain releasable particles that could degrade the class 100,000 spacecraft environment. All surfaces shall be capable of being cleaned with suitable solvents to maintain surfaces visibly clean. Class 100,000 environment is defined as not more than 100,000 particles, 1/2 micron in size or larger per cubic foot and not more than 700 particles, 5 microns in size or larger per cubic foot.

3.3.10.2 Contamination protection devices such as aperture doors, window covers, electrical heaters, and dust free storage containers shall be used as necessary.

3.3.11 COORDINATE SYSTEMS

Not Applicable

Group No.	Metallurgical category 3/	Compatible couples 1/
1	Gold, solid and plated; gold-platinum alloys; wrought platinum	
2	Rhodium plated on silver-plated copper	
3	Silver, solid or plated; high silver alloys	
4	Nickel, solid or plated; monel metal, high nickel-copper alloys, titanium	
5	Austenitic stainless steels; copper, solid or plated; low brasses or bronzes; silver solder; German silver; high copper-nickel alloys; nickel chromium alloys	
6	Commercial yellow brasses and bronzes	
7	High brasses and bronzes; naval brass; muntz metal	
8	18% chromium-type steels	
9	Chromium, plated; tin, plated; 12% chromium type steels	
10	Tin-plate; terneplate; tin-lead solders	
11	Lead, solid or plated; high lead alloys	
12	Aluminum, wrought alloys of the Duralumin type	
13	Iron, wrought, gray, or malleable; plain carbon and low alloy steels, armco iron	
14	Aluminum, wrought alloys other than Duralumin type; aluminum, cast alloys of the silicon type	
15	Aluminum, cast alloys other than silicon type; cadmium, plated and chromated	
16	Hot-dip-zinc plate; galvanized steel	
17	Zinc, wrought; zinc-base die-casting alloys; zinc, plated	
18	Magnesium and magnesium-base alloys cast or wrought	2/

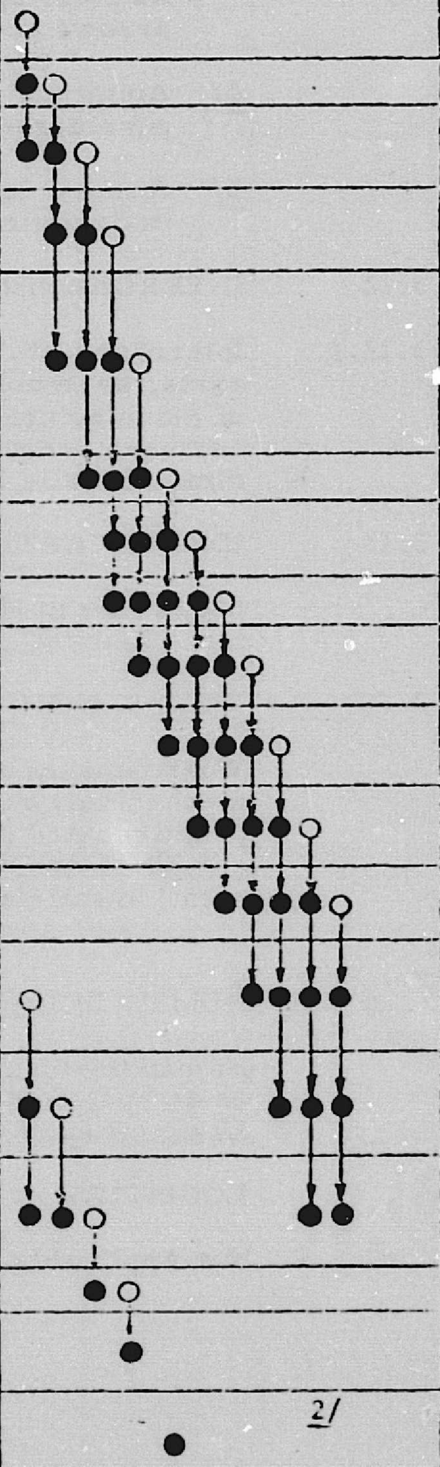

FIGURE 1. COMPATIBLE COUPLES

Footnotes 1/, 2/, and 3/ (see next page)

(see next page)

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Footnotes for Figure 1.

1/ Members of groups connected by lines will form permissible couples. O indicates the most cathodic member of the series, ● an anodic member, and the arrows anodic direction.

2/ Aluminum alloys 5052, 5056, 5356, 6061 and 6063 are considered to be compatible with magnesium alloys.

3/ A more detailed listing of metals in each group is given in Specification MIL-F-14072.

3.3.12 INTERCHANGEABILITY AND REPLACEABILITY

3.3.12.1 Interchangeability shall exist between identical replaceable parts, assemblies, subassemblies and supplies, regardless of manufacturer or supplier. All parts having the same part numbers, regardless of source, shall be functionally and dimensionally interchangeable.

3.3.13 IDENTIFICATION AND MARKING

Major assemblies and replaceable units shall be adequately identified and marked.

3.3.14 WORKMANSHIP

Workmanship on all equipment (electronic, electrical and mechanical) shall be in accordance with good commercial practices and parts shall be free of burrs, sharp edges, or any other damage or defect that could make the part (or equipment) unsatisfactory for the purpose intended.

3.3.15 HUMAN PERFORMANCE/HUMAN ENGINEERING

Human performance/human engineering requirements shall be as specified in MSFC Drawing 10M33222, "Man/Systems Design Requirements for Sortie Lab".

3.4 LOGISTICS

Not Applicable.

3.5 PERSONNEL AND TRAINING

Personnel usage and skills requirements shall be identified by the contractor for all items of equipment. Familiarization and operational training requirements shall also be identified.

4.0 VERIFICATION

4.1 GENERAL

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the verification of all performance and design requirements contained herein and shall submit a written statement verifying that all requirements herein have been met. This verification statement is subject to approval and the procuring activity reserves the right to perform any inspection, operation or test deemed necessary to assure that material and services conform to the prescribed requirements.

5.0 PREPARATION FOR DELIVERY

The Contract End Items shall be prepared for delivery in accordance with the terms of the contract. Marking shall be adequate for proper identification. Preservation, packaging, packing, handling and shipping requirements shall be compatible with commercial transportation unless otherwise specified by the contractor. Any special unpacking or handling procedural requirements shall be defined by the contractor.

6.0 NOTES

6.1 INTENDED USE

The intended use of this specification is to procure Experiment and General Laboratory Equipment and Instrumentation for support of the Sortie Lab.

Typical equipment to be procured by this specification includes but is not limited to the following:

Receivers and Transmitters - Microwave thru Laser

Optical Devices

Controls/Displays

Test, Checkout and Monitor Equipment

Calibration Devices

Data Recorders

Clocks (event timing)

Cameras - TV and Film

Cryogenic Devices - Solid Cryogenic Refrigerators, Cryostats, Cryogenic Liquid Storage

Equipment Racks and Consoles

Spark Chamber

Spectrographic Devices